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FEASIBILITY STUDY OF REMEDIAL ALTERNATIVES

BRIDGEPORT RENTAL AND OIL SERVICES SITE
LOGAN TOWNSHIP, NEW JERSEY

EPA WORK ASSIGNMENT
NUMBER 08-2M07.0
CONTRACT NUMBER 68-01-6699

NUS PROJECT NO. 0707.22

MAY 1984

218254

NUS
CORPORATION

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CONTENTS (CONTINUED)

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Introduction

A Remedial Investigation was performed by NUS Corporation in the summer and fall of 1983 at the Bridgeport Rental and Oil Services (BROS) Site. The purpose of this investigation was to characterize the types and extent of contamination at the site with the objective of using the information for the preparation of this Feasibility Study of Alternatives for the remediation of the BROS Site. The work performed during this Remedial Investigation included geophysical investigations (electromagnetic conductivity, vertical electrical sounding, and magnetometry), subsurface investigations (17 monitoring wells and two test borings), and environmental and waste sampling, including groundwater, surface water, sediment, tank waste, and lagoon waste (oil, aqueous, and sediment/sludge). Most of the analytical results from these samplings have been validated and received, with the exception of the tank samples and the second round of groundwater samples.

The Feasibility Study for the BROS Site has been prepared at the request of the United States Environmental Protection Agency (EPA) Region II under Work Assignment Number 08-2M07.0. This study was prepared in accordance with the requirements of the National Oil and Hazardous Substances Contingency Plan (NCP) published pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

The Site

? - check

The BROS Site is located in southwestern New Jersey, approximately one mile east of the Town of Bridgeport and about two miles south of the Delaware River. The total area of the site is approximately 25 acres, and the pertinent features of the site include a tank farm (containing about 90 tanks and process vessels) and a 12.7-acre waste oil and wastewater lagoon that was reportedly formed by sand and gravel mining operations. The lagoon contains a substantial quantity of water, a waste-oil layer floating on the surface of the water, and an oily sediment/sludge.

Remedial Investigation Results

The results of the Remedial Investigation at the BROS Site indicate that substantial contamination exists on and around the site. The primary contaminant source appears to be the 12.7-acre lagoon. The oil layer floating on the surface of the lagoon (estimated to be 2 to 3 million gallons) has been shown to contain Polychlorinated Biphenyls (PCBs) at an average concentration that exceeds 500 parts per million (ppm). Other contaminants detected in the oil include ethylbenzene (11.5 to 50.9 ppm) and toluene (35 to 74 ppm). The sediment phase at the bottom of the lagoon has also been shown to contain PCBs, although the distribution of PCBs in the sediment is uncertain, as demonstrated by the wide range of detected concentrations (7.5 to 2,010 ppm); nevertheless, the average of all sediment samples did exceed 500 ppm PCB. The aqueous phase of the lagoon did not show the presence of PCBs, although a variety of Hazardous Substances List (HSL) organics was detected in the parts per billion range (ppb).

The characteristics of the BROS lagoon are such that it has contaminated local groundwater, surface water, and sediment, and will continue to contaminate these environmental media unless some action is taken. The base of the lagoon extends from 5 to 10 feet into the underlying aquifer and the surface of the lagoon is 8 to 10 feet above the level of the water table. The fact that the lagoon level is above the water table results in a hydrostatic driving force that is "pushing" contaminants into the groundwater; fortunately, the oily sediment/sludge at the bottom of the lagoon acts as a semi-impermeable barrier, slowing the movement of contaminants from the lagoon into the groundwater. Nevertheless, groundwater mounding around the lagoon has been observed, indicating that the lagoon is recharging the aquifer to some degree. On the other hand, since the sediment/sludge is retarding lagoon liquid movement into the groundwater and the floating oil on the surface of the lagoon substantially reduces evaporation, the lagoon level rises with each rainfall. This circumstance has resulted in lagoon overflows and lagoon dike breaches which have caused some lagoon oil and water to contaminate surface water and sediments east and northeast of the lagoon. Currently, EMPAK, Inc., of Pennsauken, New Jersey, is under contract with the Army Corps of Engineers to remove and treat the lagoon water in an effort to reduce the lagoon level. Recent indications show that the lagoon level is falling as a result of this contract; however, unless some other action is taken, or lagoon water removal and treatment is performed ad infinitum, the lagoon level will rise once again after the EMPAK contract is completed.

I-R-M —

Groundwater contamination resulting from the BROS Site has contaminated several domestic wells west and northwest of the site and several other residential wells in this area are being threatened by contamination. Nevertheless, because of the very flat gradient of the surficial aquifer, contaminants appear to have migrated less than 1,000 feet from the site.

? what is the range (radius) of contamination.

Although the analytical data for the tank sampling have not yet been received, results from a previous investigation at the site performed by Camp Dresser and McKee (CDM), and observations made during the NUS investigation, indicate that many of the tanks in the tank farm are empty; however, several tanks contain a substantial quantity of waste material that does contain PCBs.

Air contamination at the site was investigated with an organic vapor analyzer. No volatile organics were detected above background.

Objectives and Approach

The goal of this Feasibility Study for the BROS Site is to identify and evaluate remedial alternatives for the BROS Site and to recommend the most cost-effective action for minimizing the impact of the contamination on the environment and public health.

The objectives used in developing the remedial alternatives and evaluating their effectiveness include the following:

- To minimize public health and safety impacts

- To protect the quality of local groundwater and surface water

  what about the restoration of contaminated ground water wells?

- To ensure technical feasibility, social acceptability, and cost-effectiveness of the remedial actions

The first step in selecting remedial alternatives was to identify preliminary remedial technologies for the site. These technologies were subjected to an initial screening phase in which all technologies that are not applicable, are environmentally unacceptable, or do not meet the objectives for the remediation of the site are eliminated from further consideration. The technologies that pass the initial screening are then further developed and undergo a more detailed evaluation. A major screening criterion for the BROS Site was whether a given action, when completed, would allow the lagoon waste to remain in contact with the groundwater. Any lagoon action that would allow the lagoon waste to remain in place would not significantly change the site's score with respect to the Hazard Ranking System, and therefore, would not remove the site from the National Priorities List. For this and other reasons, actions which allowed the lagoon waste to remain in contact with the groundwater were eliminated from further consideration.

?

use diff. word, or explain.

The initial screening of remedial action technologies for the BROS Site, as well as the subsequent development and evaluation of alternatives, was conducted in a manner that is consistent with the guidance provided in the NCP.

Evaluation of Alternatives

Those alternatives that passed the initial screening process were grouped into categories, depending upon the phase of the site remediation to which they pertained (e.g., lagoon waste removal, waste disposal, tank farm, residential wells). The alternatives in each category were evaluated in terms of cost-effectiveness, and the most cost-effective action in each category was selected. The selected remedial actions from each category were then combined to form the overall recommended remedial action for the BROS Site.

This overall recommended remedial action includes the following activities:

- Complete removal of the tank wastes and tanks
- Removal and onsite incineration of the lagoon oil
- Removal and onsite incineration of the lagoon sediment
- Removal and onsite treatment of the lagoon water
- Lagoon closure by leaving as a pond and revegetating the sides
- Installation of a potable-water pipeline from the Pennsgrove Water Supply Company to the affected residents

Included in the lagoon waste removal and disposal recommendations is a surficial cleanup of areas of visible oil contamination in the swamp located adjacent to the east-northeast side of the lagoon.

The construction cost estimate and the operation and maintenance cost estimate for the recommended overall remedial action are $48,000,000 and $295,000, and respectively.

1.0 INTRODUCTION

This Feasibility Study of Alternatives for the Bridgeport Rental and Oil Services (BROS) Site, Logan Township, New Jersey, has been prepared at the request of the United States Environmental Protection Agency (EPA) Region II under Work Assignment Number 08-2M07.0. This study was prepared in accordance with the requirements of the National Oil and Hazardous Substances Contingency Plan (NCP) published pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

Section 2 of this report provides background on the BROS Site, including site location and history.

Section 3 of this report presents a summary of the findings of the Remedial Investigation conducted at the site by NUS. This investigation was specifically designed to obtain the information needed to prepare this Feasibility Study. A separate Remedial Investigation Report which details the activities and findings of the Remedial Investigation was prepared by NUS and was previously submitted to the EPA as a separate document.

Section 4 of this Feasibility Study Report provides a preliminary identification of potential actions that may be applicable to the remediation of the BROS Site. Also included in Section 4 is an initial screening of these potential actions. This initial screening was performed to eliminate those technologies that are clearly not applicable to the BROS Site and to identify those actions that are worthy of further detailed development and evaluation.

Section 5 presents the detailed evaluation of remedial action alternatives for the BROS Site. The alternatives that passed the initial screening phase were grouped into categories depending upon which phase of the site remediation they addressed. The alternatives in each category were evaluated within the category and a recommended alternative from each category was selected. These recommended alternatives for each category were then combined to form the overall recommended BROS Site remedial action. Preliminary cost estimates for the alternatives are also given in Section 5.

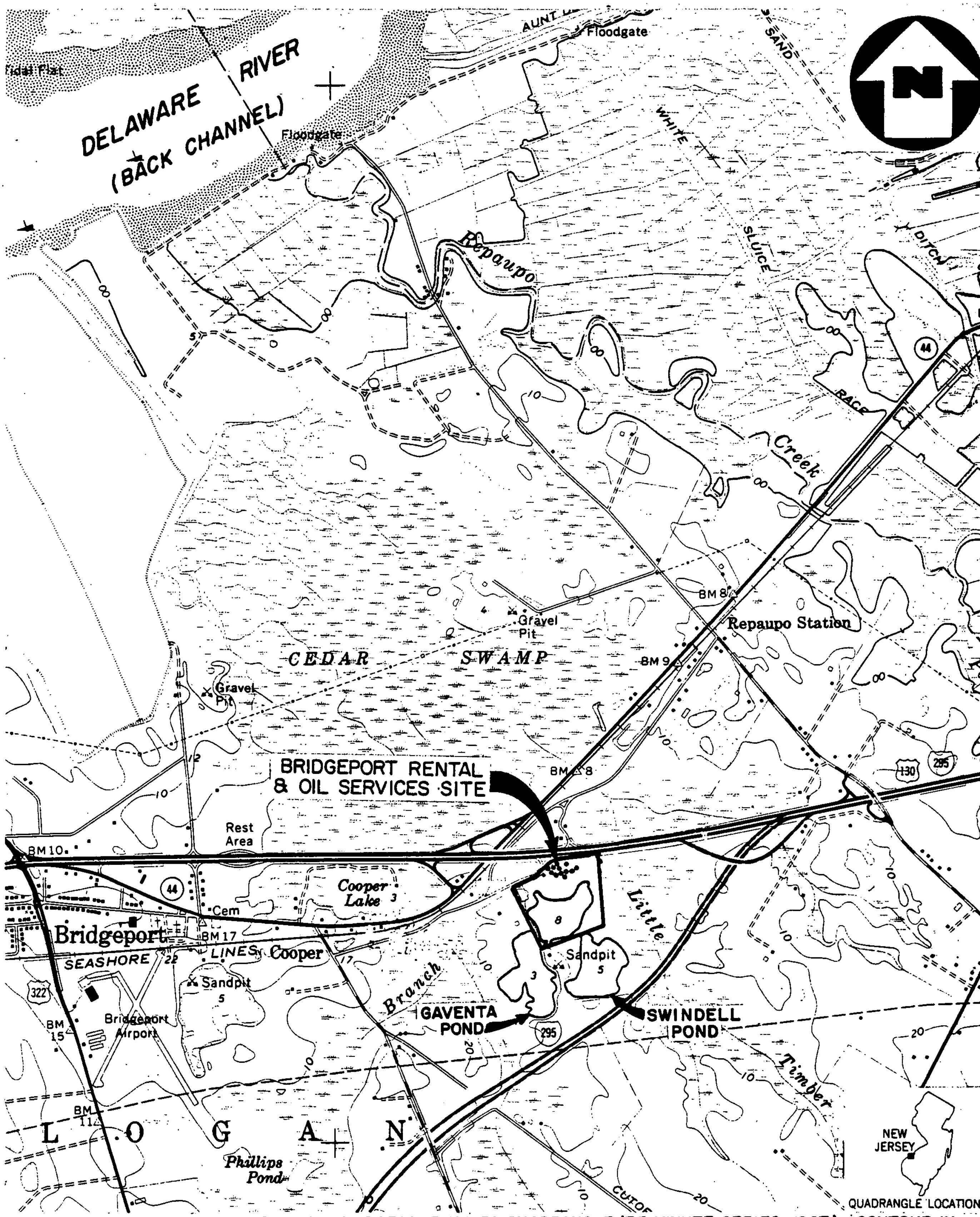
2.0 SITE BACKGROUND

2.1 Site Location

The Bridgeport Rental and Oil Services (BROS) Site is located in southwest New Jersey, approximately one mile east of the town of Bridgeport and about 2 miles south of the Delaware River, along the south side of Route 130. The general location of the site is shown in Figure 2-1. More specifically, the BROS Site is located on a parcel of land delineated as Block 59, Lots 18, 22A, 22B, and 22F on Tax Map 14A, Township of Logan, Gloucester County, New Jersey. The total area of the site is approximately 25 acres. The site consists of a tank farm containing about 90 tanks and process vessels, drums, tank trucks, and a 12.7-acre waste oil and wastewater lagoon. The lagoon was reportedly formed by previous sand and gravel dredging operations. The general arrangement of the site is shown in Figure 2-2. Drawing 0707.22-01 (provided in a pocket at the back of this report) shows the site layout and surrounding area in more detail, including the positions of local surface water bodies and the Chemical Leaman Truck Lines Site.

South and southwest of the site, adjacent to the waste oil lagoon, are three large ponds. Two of the ponds (south-southwest of the lagoon) are connected by a narrow opening and are referred to as the Gaventa Pond. The third pond is located south-southeast of the lagoon and is referred to as the Swindell Pond. The lagoon and ponds are man-made. They were excavated by a sand and gravel mining operation which started in the late 1940's and was completed by the early 1970's.

The area surrounding the BROS facility is predominantly rural and agricultural in nature, although there has been industrial development in the county. An active peach orchard (the Gaventa Orchard) borders the western edge of the BROS Site, and a private home situated within the orchard is located about 400 feet west of the lagoon. A truck repair garage is located approximately 300 feet northwest of the waste oil lagoon, and a group of four private homes is located between 800 and 1200 feet northwest of the lagoon. Three other private residences are located



BASE MAP IS A PORTION OF THE U.S.G.S. BRIDGEPORT, NJ-PA QUADRANGLE (7.5 MINUTE SERIES, 1967). CONTOUR INTERVAL 10'.

FIGURE 2-1

LOCATION MAP
BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ

SCALE: 1" = 2000'

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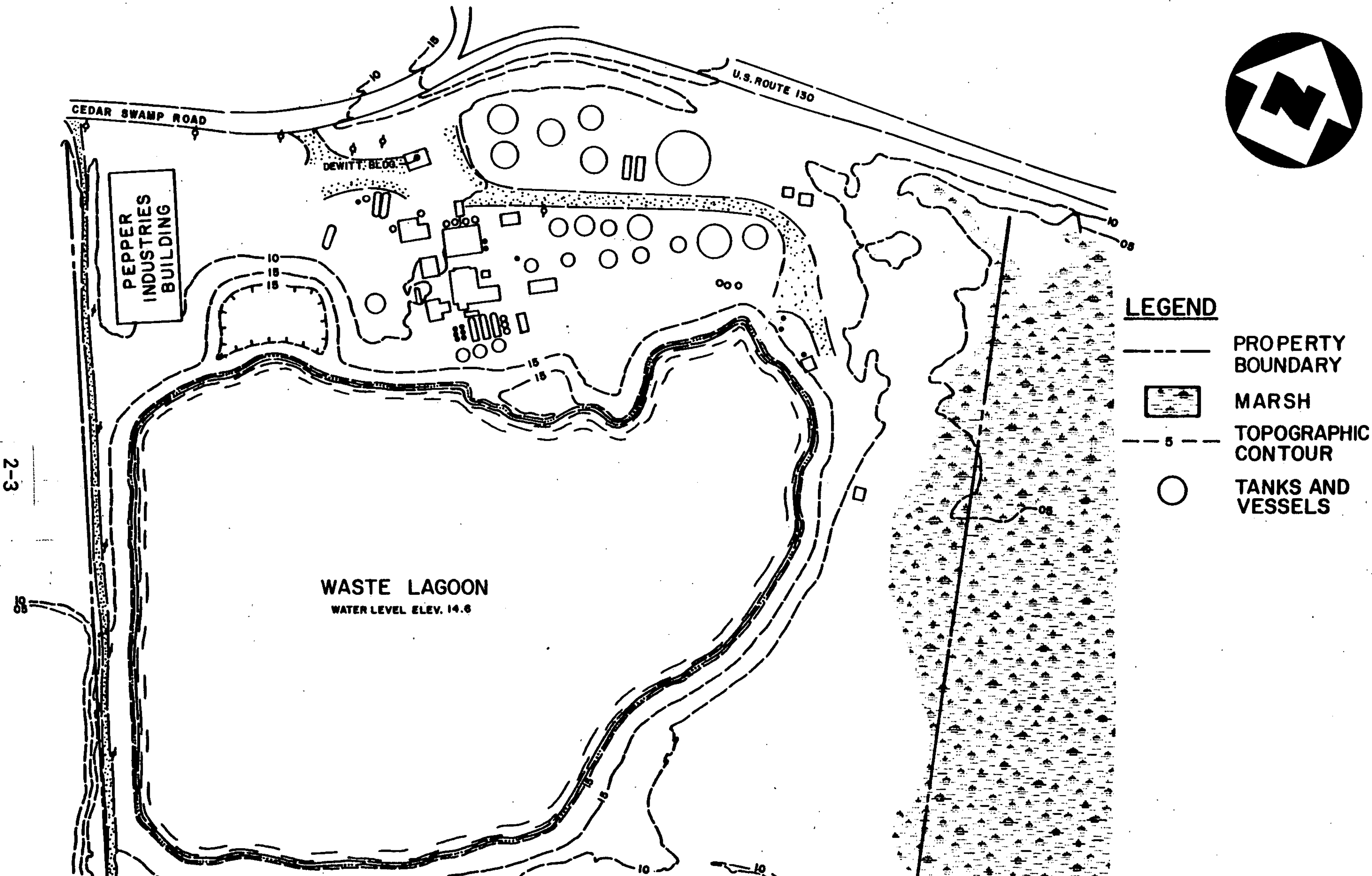

FIGURE 2-2

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GENERAL SITE ARRANGEMENT
BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ
SCALE: 1"=200'

north of the site, within 800 feet of the site boundary; however, these three homes are separated from the site by Route 130. East of the BROS facility is a swampy area (the Little Timber Creek Swamp) leading into Little Timber Creek. Several acres of the area immediately between the waste oil lagoon and the swamp contain dead or severely stressed vegetation.

Approximately 0.5 miles west of the BROS Site is the Chemical Leaman Truck Lines (CLTL) Site. Washing of tank trucks is carried out at the CLTL Site. In the past, wash water was directed to settling and seepage ponds, but this practice has reportedly been stopped.

Topography surrounding the BROS Site is nearly flat, typical of that found in the Atlantic Coastal Plain physiographic province. The Bridgeport area is bounded on the north by the Delaware River, and the local land is characterized by swamps and streams flowing north-northwest to the river.

The Bridgeport area is situated in a temperate climate influenced by maritime air masses. Winters are mild, and summers are long and hot. Precipitation occurs during all seasons; however, more precipitation generally occurs during the winter and spring months than during the summer and fall. The mean annual precipitation is 41.2 inches, with 20.3 inches occurring as snowfall. Evaporation typically removes about 28 inches of the precipitation, and runoff generally accounts for the removal of about 2 more inches, leaving about 11 inches of precipitation available for groundwater recharge. The average annual temperature is about 55°F. Prevailing winds are from the west-southwest.

2.2 Site History

The BROS Site has been used in the past for waste oil storage and recovery, and for storage tank leasing operations. Wastes have been and presently are stored in the open lagoon and in the onsite tanks. Commercial waste handling activities are presently prohibited at the site by court order; however, the wastes in the lagoon and tanks remain. The BROS Site is currently used for truck leasing and maintenance operations.

2.3 Site Investigation Objectives

Based on an initial site reconnaissance and a review of the previous site investigations performed by other contractors, NUS prepared and conducted a Remedial Investigation at the BROS Site. This investigation was designed to describe the site conditions and to provide sufficient information to develop remedial alternatives as described in the NCP. Areas of the site that were investigated include the waste oil lagoon, the tank farm, and the subsurface soils. Environmental media that were investigated include groundwater, surface water, sediment, and air. The information generated by this investigation was used to prepare this Feasibility Study of Alternatives. The purpose of this Feasibility Study is to recommend the cost-effective alternative for the remediation of the BROS Site. Section 3.0 of this report provides a summary of the Remedial Investigation results and findings that were used to develop this Feasibility Study.

3.0 SUMMARY OF THE NUS REMEDIAL INVESTIGATION ACTIVITIES AND FINDINGS

Section 3.0 presents a discussion of the Remedial Investigation activities conducted by NUS Corporation (NUS) at the BROS Site, along with a summary of the findings from these activities. For the most part, the findings presented in this Feasibility Study are based on data generated by the NUS Remedial Investigation. The primary exception is the inclusion of results from residential well sampling and analysis performed by the EPA. The results of the residential well samplings were made available to NUS by the EPA and are used in this report with the assurance from the EPA that the data are valid.

For a more detailed presentation of the Remedial Investigation activities and findings, as well as the results from previous site investigations, refer to the Remedial Investigation Report that was prepared and submitted by NUS as a separate document (NUS Project Number 0707.20).

3.1 Summary of Investigation Activities

3.1.1 Subsurface Investigation

In order to characterize the subsurface conditions beneath the BROS Site, NUS drilled 17 groundwater monitoring wells and 2 test borings in August and September of 1983. Formation samples were collected for the initial 20-foot section of most monitoring wells using a centerline split-barrel sampler. Drill cutting samples were collected at 5-foot intervals from the sand and from the gravel and clay layers from depths of about 20 feet to the bottom of the hole. Borehole geophysical logging was performed by United States Geological Survey (USGS) geologists on the two test borings and on three monitoring well borings.

Information obtained during drilling indicates that a thick clay layer exists beneath the BROS Site. The top of this clay layer is located at a depth of about 100 feet below the ground surface in the northwest corner of the site (Well S-12) and dips southeast to a depth of about 140 feet below the ground surface in the southeast corner of the site (Well S-6). This clay layer is considered to be continuous at the BROS Site, but it may not be continuous over an extensive area.

Directly above the thick clay layer is ~~located~~ the unconfined Cape May/Magothy-Raritan Formation, which is the surficial aquifer beneath the site. This formation consists of unconsolidated sands, gravels, and clay lenses and has a saturated thickness ranging from about 100 to 140 feet. Regional flow ~~of~~ in this surficial aquifer is estimated to be north toward the Delaware River; however, local flow is radial around the BROS lagoon due to mounding effects from the hydrostatic head of the lagoon.

Water level measurements conducted for the shallow, water table aquifer beneath the site indicate that the water table is relatively shallow in this area. This observation is substantiated by the existence of swamps to the east and west of the site. The water levels in the Gaventa and Swindell Ponds (adjacent to the south side of the site) appear to follow the water table elevation, which is at an elevation of about 3 feet above mean sea level ~~(MSL)~~ NGVD. Ground level at the BROS Site generally ranges from elevations of about 5 to 10 feet ~~MSL~~ NGVD. The water table fluctuates seasonally, as ~~is~~ evidenced by observed water table elevations rising an average of about 2.2 feet from September through December 1983.

Is this above or below NGVD

~~The surficial,~~ the Cape May/Magothy-Raritan Formation is used as a potable water supply in the Bridgeport area. Domestic water wells are located north, northwest, and west of the site, with ten wells located within 1000 feet of the site.

A municipal water supply well, which is screened ~~into~~ in the Magothy-Raritan Formation and ~~which is~~ operated by the Pennsgrove Water Supply Company, is located about 1 mile west of the site. The municipal well ~~services~~ serves an estimated population in excess of 800 persons (CDM).

(1)

[A confined aquifer probably exists below the thick clay layer beneath the site;] (2) [however, self-potential ~~and~~ resistivity logs (performed by USGS) from one of the

It was stated previously that the lower aquifer was confined with a clay unit. You also have geophysical evidence and water level measurements. - How can you still say 'probably'

Parts ① & ② of this sentence seem to have unrelated thoughts — needs further explanation.

test borings indicated that the water in this lower aquifer may be saline. No users of the lower aquifer were identified in the BROS Site vicinity.

3.1.2 Geophysical Investigations

Geophysical surveys were conducted at the BROS Site by NUS to aid in determining subsurface conditions. The surveys performed were magnetometry, electromagnetic profiling, and vertical electrical sounding.

The magnetometer survey was conducted along the east and west sides of the lagoon, and northwest of the lagoon in the vicinity of the Pepper Industries building. This survey was performed in order to define areas that may be underlain by ferromagnetic materials. Two anomalous areas, indicating possible buried ferromagnetic material, were observed along the western side of the lagoon. One of these anomalies appears to be caused by a visible pipe which connects the BROS lagoon and the Gaventa Pond. The source of the other anomalous area is unknown. Four anomalies were observed in the vicinity of the Pepper Industries building (northwest of the lagoon); and at least five major anomalies were observed in the area adjacent to the east side of the lagoon. The sources of these anomalies, as well as the depths of these sources, could not be determined by the magnetometer survey. Test pits should be dug during site cleanup activities to confirm the presence of buried ferromagnetic material and to assess whether the material should be removed from the site.

Electromagnetic profiling was performed in an attempt to locate plumes of contaminated groundwater. While it is recognized that electromagnetic profiling is basically incapable of tracking organic contaminants, the tracking of conductive contaminants (e.g., chloride) by electrical methods can be used to indicate the direction of movement and relative extent of organic groundwater contamination by taking into account retardation factors. Based on the electromagnetic profiling data, it appears as though there are three plumes of groundwater contamination spreading away from the site. These plumes appear to be spreading to the east-northeast from the lagoon, to the west-northwest from the lagoon, and to the south from the lagoon. The profiling data also indicate that the plumes have migrated less than 500 feet from the lagoon, despite the hydrostatic head of the lagoon and the mounding effects around the lagoon. This relatively small amount of contaminant migration is believed to be attributable to the flat hydraulic gradient of the water table.

Vertical electrical soundings were performed at the BROS Site in order to provide information about background resistivity values for the area. These vertical electrical sounding data were used to correlate with the electromagnetic profiling data.

3.1.3 Environmental and Waste Sampling

Environmental and waste sampling was performed at the BROS Site in order to determine the extent of contamination of environmental pathways and to evaluate the hazardous nature of wastes currently stored on the site. Samples were collected from the following media: groundwater, surface water/sediment, air, tank and drum wastes, and lagoon wastes (oil, aqueous, and sediment phases). The available results from the analyses of these samples are summarized in Section 3.2. Unfortunately, as of the time of this writing (April 1984), a considerable portion of the analytical data has not been received by NUS for evaluation and inclusion in this report.

Groundwater sampling of the EPA and NUS monitoring wells was performed in November 1983. The validated results from the analysis of these samples have been received and were used in this Fesibility Study to assess the extent of groundwater contamination. A second round of groundwater sampling was conducted in January 1984; however, the results from this sampling round have not yet been received by NUS from the EPA Region II Environmental Services Division (ESD).

Sampling of domestic water wells in the vicinity of the site was performed by the EPA. The analytical results from this sampling, for the period from March 1983 to

November 1983, were available for the preparation of this report. These data are used in this Feasibility Study for the evaluation of residential drinking water alternatives.

Surface water and sediment sampling was performed by NUS during the Remedial Investigation. Samples were collected from the Gaventa and Swindell Ponds, and from the Little Timber Creek and Little Timber Creek Swamp east of the site. The analytical results from these samples are available and have been validated by the ESD.

Samples of the BROS lagoon (oil, aqueous, and sediment phases) were collected by NUS in August 1983. Four line-traverses across the lagoon were made, with samples of each lagoon phase being taken at three points along each traverse line. The three samples of each phase (collected from each traverse) were composited to yield one composite sample per lagoon phase for each line-traverse (resulting in four composite samples of each phase plus one duplicate for each phase, for a total of five samples of each lagoon phase). The analytical results from the lagoon sampling are available and have been validated by the ESD.

In addition to the lagoon sampling performed as part of the Remedial Investigation, samples of the lagoon oil and sediment were collected in January 1984. These lagoon samples were used for the testing that was performed as part of the Treatability Study for the BROS Site. A detailed discussion of the Treatability Study and its finding is presented in Appendix A of this report.

Tank samples were also collected from the tank farm at the BROS Site. These tank samples included bulk waste samples from full or partially full tanks and wipe samples from empty tanks. Unfortunately, none of the results from the analysis of these samples have been made available by the EPA to NUS as of this writing.

As previously mentioned, some of the data from the analysis of samples collected during the Remedial Investigation have not yet been received by NUS from the EPA. Nevertheless, the authors of this document have concluded that this draft

Feasibility Study could be prepared in reasonable fashion without these data, although all data will need to be validated and received by NUS before this study can be finalized. Since the tank waste analyses have not yet been received by NUS, the cost estimates developed for tank waste disposal will not have a high level of confidence. One area in which the delay in receiving validated data may adversely affect this Feasibility Study is with respect to the results of some of the Treatability Study testing. In particular, specially stabilized lagoon sediment samples were analyzed for their leachability characteristics in order to evaluate the alternatives of "in-situ stabilization" or "stabilization and offsite landfilling." As of this writing (April 1984), the results of the leachability characterization have not been validated by EPA Region II ESD and have not been received by NUS. Without these leachability data, the stabilization alternatives cannot be adequately evaluated.

3.2 Summary of Remedial Investigation Findings

Section 3.2 presents a preliminary summary of the analytical results pertaining to the media sampled at the BROS Site. Also included, where appropriate, are discussions of the conclusions and interpretations developed from these findings.

3.2.1 Lagoon

The primary concern at the BROS Site is the 12.7-acre, open, unlined lagoon. This lagoon primarily contains an aqueous phase which has been contaminated by organic materials that appear to mainly consist of used motor oil. An oily layer floats on the surface of the lagoon and an oily sediment/sludge exists at the bottom of the lagoon. The lagoon is littered with miscellaneous debris, drums, and thousands of glass and plastic bottles. It has been rumored that tank cars, trucks, and other large objects are contained within the lagoon.

The analytical results for each of the lagoon phases sampled indicate that Polychlorinated Biphenyls (PCBs) are the primary contaminant of concern, especially in the oil and sediment.

3.2.1.1 Analytical Results

Oil Phase

Results from the analyses of lagoon oil samples show the presence of PCBs at levels ranging from less than 100 parts per million (ppm) to 1380 ppm, with the average PCB concentration from the five samples being 667 ppm. Lagoon oil samples analyzed by subcontracted labs as part of the Treatability Study had PCB concentrations ranging from 105 ppm to 882 ppm, with an average PCB level of 624 ppm for the four Treatability Study samples. Appendix A presents more detail on the Treatability Study.

Other Hazardous Substance List (HSL) organics detected in the lagoon oil were limited to ethylbenzene and toluene. Ethylbenzene was observed at concentrations ranging from 11.5 ppm to 50.9 ppm. Toluene was detected at levels ranging from 35 ppm to 74 ppm.

Metals analysis of the lagoon oil (from the Treatability Study) indicates elevated concentrations of lead (160 to 1525 ppm), nickel (1.0 to 6.0 ppm), barium (40 to 180 ppm), chromium (2.0 to 29 ppm), and mercury (<0.15 to 0.25 ppm).

From these oil analyses, it is apparent that PCBs are the most critical contaminant present in the oil, especially in terms of evaluating disposal options. Also, it is apparent that the lagoon oil must be categorized as a PCB-contaminated waste containing greater than 500 ppm PCB.

Sediment Phase

Analytical results from the five lagoon sediment samples taken and analyzed as part of the NUS Remedial Investigation indicate that PCB levels in the sediment range from 190 ppm to 1400 ppm, for an average of 570 ppm. Results for the four sediment samples analyzed in the Treatability Study showed PCB concentrations ranging from 7.5 ppm to 2010 ppm, with an average of 512 ppm.

A full Hazardous Substance List scan was not performed on the lagoon sediment; however, Extractive Procedure (EP) Toxicity analyses were performed for metals, pesticides, and herbicides. No concentrations in excess of the EP Toxicity criteria were observed.

Metals analysis of the lagoon sediment, performed during the Treatability Study, revealed the presence of lead (368 to 760 ppm), chromium (12 to 25 ppm), nickel (9.2 to 31 ppm), and arsenic (0.53 to 7.6 ppm).

From the analytical results of the lagoon sediment, it is apparent that PCBs are the most critical sediment contaminant, especially in terms of identifying potential remedial alternatives. However, unlike the oil samples, there is some doubt as to whether the sediment must be categorized as containing greater than 500 ppm PCB, particularly with respect to the Treatability Study data (Table A-3 in Appendix A). Whether the sediment is categorized as containing greater than 500 ppm PCB or categorized as containing between 50 and 500 ppm PCB will be of utmost importance with respect to the method of disposal.

Aqueous Phase

Unlike the lagoon oil and sediment, no PCBs were detected in any of the five lagoon water samples. This observation is not surprising since PCBs have a very low solubility in water.

HSL organics analysis of the lagoon aqueous phase revealed the presence of a number of organic species, although substantial concentrations were not observed. Organics that were detected include: 2,4-dimethyl phenol (not detected or ND to 64 parts per billion or ppb); phenol (ND to 270 ppb); 4-methyl phenol (ND to 190 ppb); 2-methyl phenol (ND to 112 ppb); naphthalene (ND to 70 ppb); bis-(2-ethylhexyl)phthalate (ND to 24 ppb); butyl benzyl phthalate (ND to 50 ppb); phenanthrene (ND to 24 ppb); 2-methylnaphthalene (28 to 44 ppb); benzyl alcohol (ND to 90 ppb); benzene (34 to 86 ppb); 1,1,1 trichloroethane (ND to 19 ppb); 1,2-trans-dichloroethylene (140 to 280 ppb); ethylbenzene (ND to 100 ppb); toluene

(30 to 450 ppb); trichloroethylene (ND to 11 ppb); acetone (510 to 1200 ppb); o-xylene (43 to 130 ppb); and 1,2-dichloropropane (ND to 16 ppb).

Analyses performed on the lagoon water by CDM in July 1981 indicated that elevated levels of metals are present in the water. Metals detected at significant concentrations included: cadmium (less than 100 to 110 ppb), chromium (240 to 2,800 ppb), copper (less than 10 to 3,020 ppb), lead (400 to 656,600 ppb), mercury (12 to 60 ppb), selenium (less than 10 to 168 ppb), and zinc (460 to 52,800 ppb).

From the analytical results of the aqueous phase of the lagoon, it is fairly obvious that the lagoon water would be detrimental to human health if ingested and detrimental to the local environment if discharged without treatment. Furthermore, even though PCBs were not detected in the aqueous phase, the aqueous phase may still require disposal as a PCB-contaminated material since it is in direct contact with the PCB-contaminated oil and sediment. An official interpretation of the PCB regulations will be required to resolve this issue. Nevertheless, this Feasibility Study assumes that the lagoon water will not be categorized as a PCB waste.

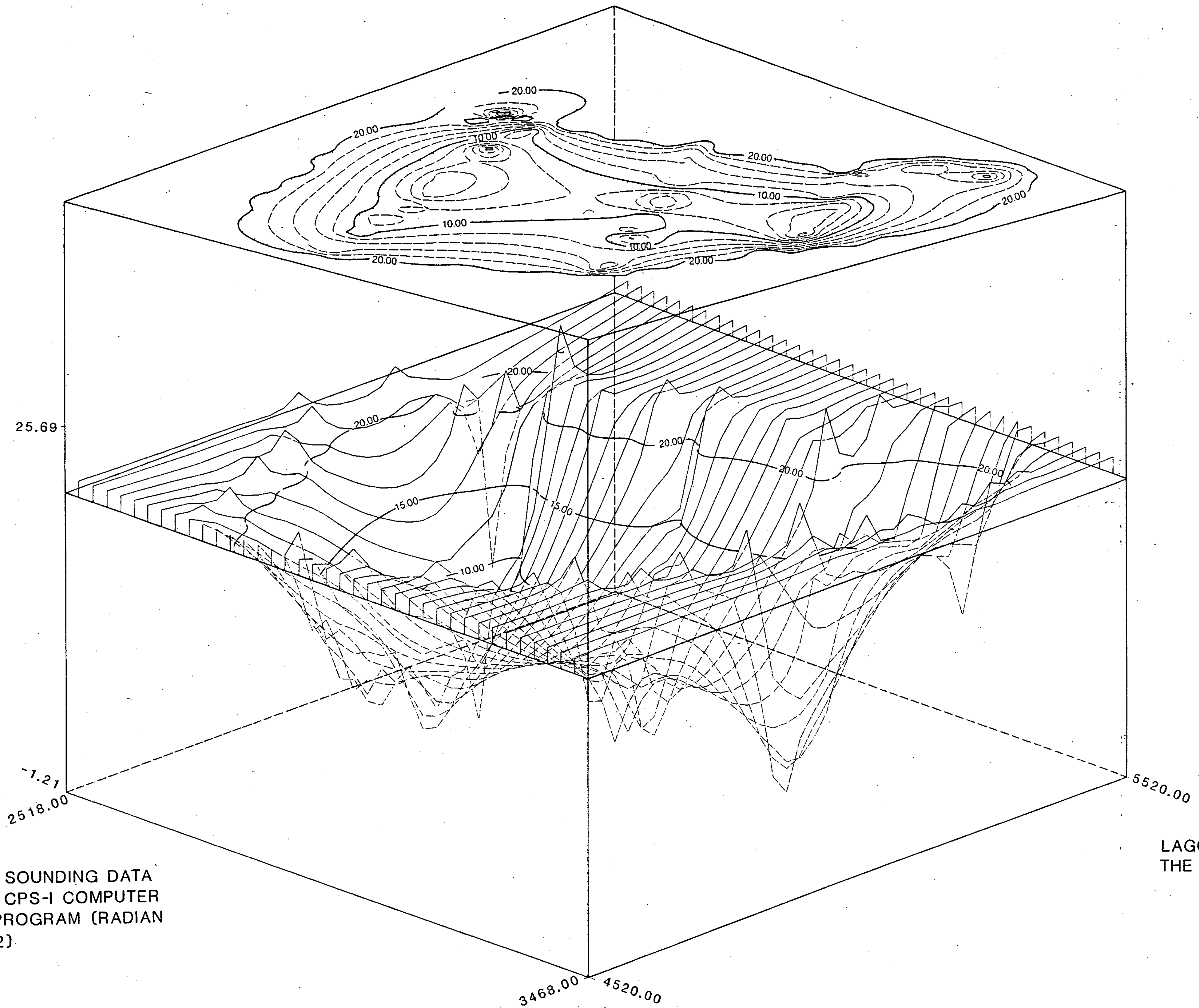
3.2.1.2 Lagoon Characterization

Allowed to remain unattended, assuming that the lagoon dikes do not fail, the lagoon level rises with each rainfall. The reason for this is threefold: (1) the lagoon has no provision for surface water discharge, (2) the oily layer floating on the lagoon prevents evaporation of lagoon water, and (3) the oily sediment/sludge at the bottom of the lagoon acts to partially seal liquid in the lagoon. Therefore, any precipitation that falls on the lagoon is "trapped," increasing the amount of the aqueous phase. Consequently, if no action is taken on the lagoon, the lagoon level would continue to rise, eventually overtopping the dikes and spreading contaminated material over the surrounding area. Even if the lagoon level is monitored and controlled, one of the dikes could fail, allowing the lagoon contents to contaminate the surrounding areas.

As a result of the tendency for the lagoon level to rise, and because in the past the lagoon dikes were raised whenever it appeared as though the lagoon were going to overflow, the lagoon level now is about 5 feet above the grade level of the tank farm area north of the site and about 10 feet above the water table. This 10 feet of hydraulic head from the lagoon tends to act as a driving force, "pushing" the contaminated lagoon water and wastes into the groundwater. The semi-impermeable oily sediment at the bottom of the lagoon does help to prevent infiltration of lagoon water into the local groundwater; nevertheless, groundwater mounding was observed around the lagoon during the NUS Remedial Investigation. This mounding indicates that the contaminated lagoon water is, to some degree, recharging and therefore contaminating the local groundwater.

In an effort to prevent any future overflows and to reduce or eliminate the hydrostatic driving force of the lagoon, the Army Corps of Engineers awarded a contract to EMPAK, Inc., of Pennsauken, New Jersey, to remove and treat lagoon water. Using a treatment system design developed by Camp Dresser and McKee (CDM), EMPAK built the water treatment facility and began actively treating lagoon water in November 1983. The system was shut down for the winter in December 1983 and was restarted on February 27, 1984. Optimum treatment plant operation seems to be about 150 gallons per minute (gpm) of effluent, which is discharged to nearby Little Timber Creek. From the time that the plant was brought into production until the time of this writing (April 1984), the lagoon level has been dropped by about 2 feet. EMPAK's contract with the Army Corps of Engineers calls for the lagoon level to be dropped down to the level of the water table (an estimated quantity of 35 million gallons), and EMPAK feels that this could be accomplished some time in 1984. A potential problem associated with this contract with EMPAK is that the lagoon level is to be lowered without removing the floating oil layer. This situation may complicate the ultimate clean-out of the lagoon and may increase the overall cost of the cleanup. This issue is discussed in more detail in Section 5.3.1.4, Lagoon Cleanout.

The profile of the lagoon bottom was also investigated by NUS during the Remedial Investigation. The lagoon profile was developed from 72 depth soundings that were



VERTICAL DATUM IS ARBITRARY.

LAGOON SURFACE IS AT APPROXIMATELY THE 20 FOOT CONTOUR.

SOURCE: NUS DEPTH SOUNDING DATA INPUT INTO CPS-I COMPUTER GRAPHICS PROGRAM (RADIAN CORP., 1982)

FIGURE 3-1

BROS LAGOON - ISOMETRIC NET PLOT

BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ

NUS CORPORATION
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taken when the lagoon sampling was being performed (along the four line-traverses). These depth sounding data were input into a computer graphics program that was developed by Radian Corporation[1]. Figure 3-1 shows the three-dimensional portrayal of the lagoon that was developed by the graphics program. From this portrayal, and from the contour lines drawn by the graphics program, the volume of liquid in the lagoon was calculated. When the lagoon level is at an elevation of 14 feet MSL, the volume of the liquid contents is calculated to be about 36,000,000 gallons (including both water and oil).

3.2.2 Groundwater

This section presents a discussion of the findings related to the local groundwater. First is a discussion of the analytical results obtained from the sampling of NUS and EPA monitoring wells in November 1982. Next, there is a discussion of the residential well sampling data provided by the EPA. Finally, there is a presentation of the results from groundwater flow modeling as related to plume migration under various conditions of groundwater extraction and lagoon surface elevation.

Monitoring Wells

Sixteen NUS monitoring wells and eight EPA monitoring wells were sampled in November 1983. The validated results from this sampling have been received from the EPA Region II ESD. These results confirm the presence of a plume of groundwater contamination emanating from the BROS lagoon in at least three locations, as was suggested by the electromagnetic profiling performed during the geophysical investigation and was confirmed by groundwater sampling. The general location of these plumes, as well as the locations of the monitoring wells, is shown on Drawing 0707.22-01, which is in a pocket at the back of this report. The

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1 CPS-1 Computer Graphics Program, Radian Corporation, Austin, Texas, Copyright 1982.

groundwater monitoring results are presented in greater detail in the Remedial Investigation Report.

Wells adjacent to the south side of the lagoon (EPA 101 and well cluster S-1A, S-1B, and S-1C) showed organic contamination in the form of methylene chloride at levels ranging from 11 to 74 ppb in three wells and at a level of 11,000 ppb in well S-1B. Other organics observed included one detection of trichloroethylene at 110 ppb in well S-1B, one positive detection of bis(2-ethylhexyl)phthalate at 43 ppb in well S-1A, and a measurement of 6,200 ppb for petroleum hydrocarbons in well EPA 101. It should also be noted that approximately 1/4 inch of oil was observed floating on the surface of the water table in well S-1A.

Inorganics observed at significant concentration in the monitoring wells directly south of the lagoon included iron, manganese, zinc, and lead. Secondary drinking water standards were exceeded in all monitoring wells directly south of the lagoon for iron (5,150 to 14,600 ppb), manganese (315 to 1,740 ppb), and zinc (12,700 to 43,000 ppb). The primary drinking water standard for lead was not exceeded, with lead concentrations ranging from 5 to 45 ppb.

Monitoring well S-6, which is located south-southeast of the BROS lagoon and is separated from the lagoon by Swindell Pond, showed the presence of 1,1,1-trichloroethane at 12 ppb and methylene chloride at 10 ppb. Petroleum hydrocarbons were observed at a concentration of 15,500 ppb in well S-6. Inorganics detected in well S-6 included iron at 2,700 ppb, manganese at 90 ppb, zinc at 9,930 ppb, and lead at 30 ppb.

The groundwater directly north-northwest of the lagoon exhibited higher levels of contamination than the groundwater south of the lagoon, as is indicated by the results from well cluster S-3 (Wells S-3A, S-3B, and S-3C). Organics detected in the S-3 wells include: benzene (not detected or ND to 360 ppb), methylene chloride (15 to 10,000 ppb), toluene (ND to 1,000 ppb), 2-butanone (ND to 34 ppb), 4-methyl-2-pentanone (ND to 1,500 ppb), bis(2-chloroethyl)ether (ND to 72 ppb), isophorone (ND to 26 ppb), benzyl alcohol (ND to 600 ppb), and hexachloroethane

(ND to 80,000 ppb). Well S-3A (the shallow well of the cluster) consistently exhibited the worst water quality in the S-3 cluster. Surprisingly, well S-3B (the intermediate well) showed the best water quality of the cluster. Inorganics detected in the S-3 cluster included iron (30,100 to 118,000 ppb), manganese (570 to 2,430 ppb), zinc (570 to 116,000 ppb), and lead (10 to 70 ppb). Well S-3A was highest in iron and lead levels; well S-3C was highest in the other inorganics.

Moving farther to the northwest, away from the lagoon, monitoring wells EPA 103, EPA 105, and EPA 106 showed a significant improvement in the groundwater quality over the contamination observed in the S-3 well cluster. The only organics observed in these wells were 1,2-trans-dichloroethylene (ND to 5 ppb), methylene chloride (9 to 57 ppb), and acetone (ND to 21 ppb). Inorganics observed in wells EPA 103, 105, and 106 included iron (6,300 to 23,600 pb), manganese (45 to 10,500 ppb), zinc (15,900 to 65,500), and lead (15 to 80 ppb).

To the west of the BROS Site, the groundwater quality was comparable to that observed in the wells directly south of the site. Monitoring wells S-4 and EPA 102 (located roughly in the center of the Gaventa peach orchard) showed the presence of methylene chloride (12 to 3,600 ppb), 1,2-trans-dichloroethylene (ND to 8 ppb), toluene (ND to 74 ppb), trichloroethylene (ND to 8 ppb), and bis(2-ethylhexyl)phthalate (ND to 12 ppb). Inorganics detected in the groundwater west of the site included iron (3,100 to 15,000 ppb), manganese (180 to 915 ppb), nickel (ND to 40 ppb), zinc (240 to 29,800 ppb), and lead (10 to 100 ppb).

The groundwater east and northeast of the BROS lagoon showed substantial organic contamination, with the groundwater east of the lagoon exhibiting the poorest quality. Well cluster S-2 (northeast of the lagoon) and well cluster S-11 (east of the lagoon) showed the following contaminants: benzene (ND to 800 ppb), chlorobenzene (ND to 130 ppb), 1,1,1 trichloroethane (ND to 840 ppb), 1,1,2,2-tetrachloroethane (ND to 430 ppb), 1,2-trans-dichloroethylene (ND to 520 ppb), ethylbenzene (4 to 490 ppb), methylene chloride (44 to 6,900 ppb), toluene (28 to 3,100 ppb), trichloroethylene (10 to 9,000 ppb), acetone (ND to 73,000 ppb), 2-butanone (ND to 4,900 ppb), 4-methyl-2-pentanone (ND to 9,600 ppb), 2,4-dimethylphenol (ND to 180 ppb); benzoic acid (ND to 5,600 ppb), 2-methylphenol (ND to 380 ppb), 4-methylphenol (ND to 510 ppb), bis(2-chloroethyl)ether (86 to 990 ppb), isophorone (ND to 2,800 ppb), bis(2-ethylhexyl)phthalate (ND to 110 ppb), and benzyl alcohol (ND to 5,200 ppb). In addition, approximately 5 inches of oil was observed floating on the water table in well S-11A.

Inorganics detected in the groundwater east and northeast of the lagoon included iron (53,700 to 639,000 ppb), manganese (1,830 to 6,230 ppb), nickel (ND to 400 ppb), vanadium (ND to 4,200 ppb), zinc (7,490 to 310,000 ppb), and lead (20 to 120 ppb).

In summary, it appears as though there is a plume of contaminated groundwater emanating from the lagoon in at least three places. The contaminant plume to the south was the least contaminated, followed by the plume exiting to the northwest. The plume exiting to the east-northeast from the lagoon showed the poorest groundwater quality. From the available data (for the plumes to the south and to the northwest of the lagoon), it appears as though the groundwater plumes have not spread far from the lagoon, as is evidenced by a substantial improvement in groundwater quality at a distance of 400 to 600 feet away from the lagoon. The reasons that plume migration is limited are as follows: (1) the water table gradient is very flat beyond the influence of the lagoon; (2) no high-volume pumping wells are located nearby the site; and (3) the plume to the east-northeast of the lagoon discharges to Little Timber Creek Swamp, where conditions for the biodegradation of the organic contaminants may be favorable. No PCBs were detected in any groundwater samples.

Residential Wells

Information provided by the EPA on the quality of residential well water in the BROS Site vicinity indicates that contamination of residential wells has occurred; however, not all of the observed domestic well contamination is attributable to the BROS Site. Drawing 0707.22-01 shows the locations of some of the residential wells tested by the EPA; the remainder of the wells were not included on this drawing because they are beyond the aerial coverage of the drawing. Drawing 0707.22-01 is provided in a pocket at the back of this report.

Ten wells in the vicinity of the BROS Site are now affected, or are expected to become affected in the future, by the groundwater contamination emanating from the BROS Site. These wells are located west, northwest, and north of the site and are referred to by the following names: Keller, Pepper Industries, Fish Diesel Repair, Byrnes, Lindle, Newton, Cahill, Hillman, Freyberger, and Bell. Of these wells, the Keller well has shown the highest level of organic contamination in the form of 1,2-trans-dichloroethylene (30 to 62 ppb), tetrachloroethylene (11 to 20 ppb), trichloroethylene (180 to 290 ppb), and vinyl chloride (ND to 11 ppb). The Keller well has been fitted with a carbon filtration unit which has demonstrated satisfactory removal of these organic contaminants. The Pepper Industries well has shown some contamination, which is primarily trichloroethylene (2 to 8.4 ppb). Benzene (ND to 6.4 ppb), 1,1,1-trichlorethane (ND to 4.5 ppb), and tetrachloroethylene (ND to 2.7 ppb) were also detected in the Pepper Industries well. Low levels of organic contamination were also detected in the group of three residential wells located about 1,000 feet northwest of the site. The contamination detected in these three wells consisted of trichloroethylene (ND to 2 ppb) in the Cahill well, 1,2-dichloropropane (ND to 27 ppb) in the Lindle well, and toluene (ND to 4.7 ppb) and benzene (ND to 2 ppb) in the Newton well. The five remaining residential wells (Byrnes, Fish Diesel Repair, Hillman, Fryberger, and Bell) that are believed to be potentially influenced by the groundwater contamination exiting from the BROS Site have not yet shown any organic contamination. Possible groundwater mounding effects resulting from rainwater runoff from Route 130 may prevent northerly migration of contaminated groundwater from the BROS Site.

Four residential wells (August, Mikuletsky, Trew, and Wilson) that are located about 2,400 feet west of the BROS Site have also shown organic contamination. The Mikuletsky well has shown the highest level of contamination of these four wells with the following organics being detected: benzene (ND to 9.3 ppb), chlorobenzene (5 to 13 ppb), 1,2-dichloroethane (55 to 93 ppb), 1,2-trans-dichloroethylene (130 to 370 ppb), tetrachloroethylene (18 to 55 ppb), trichloroethylene (17 to 40 ppb), and vinyl chloride (17 to 170 ppb). The August well also showed substantial contamination in the form of 1,2-trans-dichloroethylene (7.1 to 20 ppb) and trichloroethylene (10 to 210 ppb). The Trew well showed only trichloroethylene contamination at levels ranging from 3.3 to 6.7 ppb. The Wilson well exhibited tetrachloroethylene contamination ranging from ND to 11 ppb. The August well and Mikuletsky well are both fitted with carbon filtration units. The unit on the August well appears to be performing adequately based on the analysis of water samples taken before and after the carbon filter; however, the Mikuletsky carbon filter does not seem to be doing a satisfactory job of organics removal.

Although the four wells just discussed show contamination with organics similar to those detected near the BROS Site, an evaluation of the analytical data and the hydrogeological data has lead to the conclusion that these wells are being contaminated by some other source. For example, 1,2-dichloroethane and vinyl chloride were not detected in any BROS monitoring wells, and significant levels of 1,2-trans-dichloroethylene (i.e., in excess of 50 ppb) were detected only in the S-11 monitoring well cluster located on the east side of the lagoon. Also, an evaluation of the monitoring well chemical data has indicated that the groundwater quality improves substantially within a distance of about 800 feet from the lagoon. On the other hand, the Mikuletsky well (about 2,400 feet west of the BROS lagoon) shows substantial concentrations of 1,2-dichloroethane, vinyl chloride, and 1,2-trans-dichloroethylene. Furthermore, there are two groundwater discharge zones (Cedar Creek Swamp and Cooper Lake) located between these four wells and the BROS Site. For these reasons, it is believed that the four wells located about 2,400 feet west of the BROS Site are being contaminated by some other source.

Five residential wells located to the southwest of the Site (Stull, Panserra, Parisi, Beckett, and Coco) were sampled and no organic contamination was found. Since these wells are upgradient of the BROS Site (based on the regional groundwater flow direction), they (?) have not demonstrated organic contamination, and are separated from the site by two groundwater discharge zones (Cedar Creek Swamp and

Incomplete sentence

Gaventa Pond), it is believed that these wells are not influenced by the groundwater contamination at the BROS Site.

A number of wells located between 3,000 and 4,000 feet west of the site were also tested. These wells are believed to be too far from the BROS Site to be influenced by groundwater contamination coming from the site, based on the reasoning previously used for the Mikuletsky well and other wells in that area. Contamination detected in those wells located 3,000 feet or more from the site is expected to be coming from some other source.

Similarly, several wells located between 3,000 and 4,000 feet northeast of the site are believed to be beyond the influence of groundwater contamination from the BROS Site. Additionally, these wells are separated from the site by Little Timber Creek and Little Timber Creek Swamp, which are groundwater discharge zones.

<u>Groundwater Modeling</u>

Various calculations and models for the groundwater system in the vicinity of the BROS Site were performed using the aquifer characteristics defined during the Remedial Investigation. This discussion presents the relevant information generated by these calculations and models. Appendix B provides further detail on the methods used for this modeling.

The groundwater models were based on the following assumptions.

- Flow Model

  The aquifer was modeled as two-dimensional, non-steady state, heterogeneous, and anisotropic with unconfined conditions. The transmissivity of the oily sludge in the lagoon was varied over several simulations in order to recreate the mounding effects of the lagoon. Recharge boundaries (such as ponds) and groundwater mounding from topographic high points were also simulated.

- Transport Model

The transport model was a two-dimensional, homogeneous, and isotropic simulation under unconfined conditions. In order to simulate a worst-case situation, no retardation of contaminant migration was assumed to have occurred from interaction between the contaminant and the groundwater or aquifer. The concentrations of chlorides in the monitoring wells were used to simulate contaminant dispersion at the beginning of the model.

The actual contaminants are mostly organic chemicals; therefore, some interaction may occur between the contaminants and the groundwater or aquifer.

The size and spacing of the two-dimensional grid was smaller for the groundwater flow model since the lagoon mounding was the center of the investigation. The grid size was enlarged for the contaminant transport simulations to demonstrate the extent of plume dispersion.

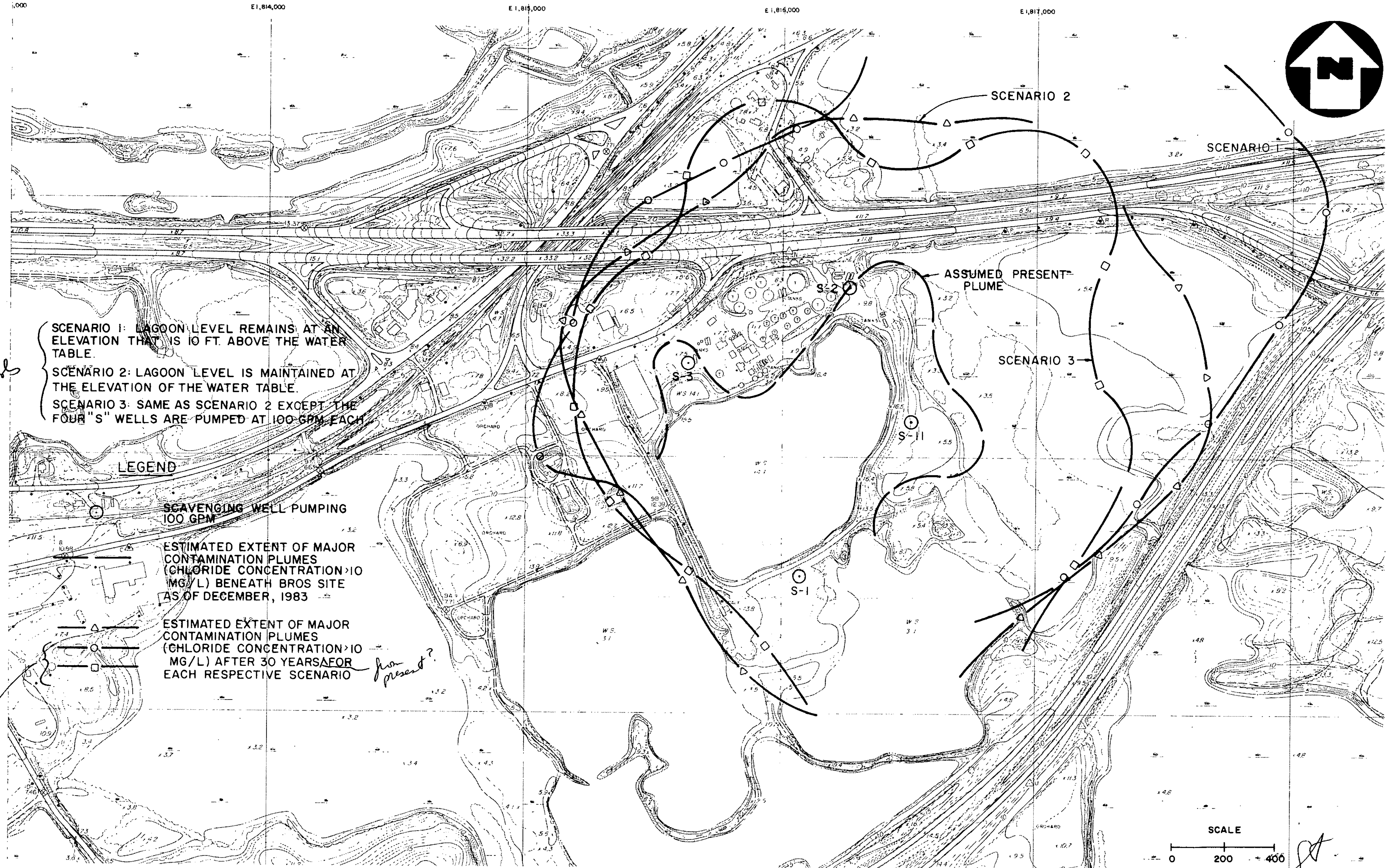
According to your figures you'd have to pump 4.9932×10^{10} gal. or (50 Trillion gal) of H_2O from the area ?

Based on the aquifer characteristics as determined by an NUS pumping test and based on the best available information pertaining to the extent of groundwater contamination attributable to the BROS Site, the amount of water that would need to be withdrawn from the aquifer to remove the contaminated groundwater was calculated. From this calculation it was determined that very high pumping rates (19,000 gpm) would be required over a long period of time (5 years) to remove the contaminated groundwater.

If you consider the effective porosity (38%) it becomes 19 trillion gal!

Where is the data ?

Groundwater contamination migration was modeled using the Random Walk version of the Solute Transport and Dispersion Model by Prickett run on a COMPAQ microcomputer using MS-DOS in Microsoft BASIC. Three scenarios were modeled over a 30-year period and are graphically illustrated on Figure 3-2. Each of the scenarios referenced on Figure 3-2 is described below:



Meaning of these two symbols -o- , -□- are unclear

FIGURE 3-2

NUS CORPORATION
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GROUNDWATER MODELING OF CONTAMINANT MIGRATION

BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ

SCALE : 1" = 400'

- Scenario 1 (Lagoon Mounding) - This scenario models the groundwater contaminant dispersion over a 30-year period, assuming that the lagoon surface remains at a level 10 feet above the water table.

- Scenario 2 (Plume Dispersion) - This scenario models the groundwater contamination dispersion over a 30-year period, assuming that the lagoon dikes are removed and the lagoon surface is maintained at the level of the water table.

- Scenario 3 (Scavenging Wells) - This scenario models the groundwater contamination dispersion over a 30-year period, assuming that the lagoon dikes are removed, the lagoon surface is maintained at the level of the water table, and that the four monitoring wells (S-1, S-2, S-3, and S-11) are each pumped at a rate of 100 gpm (400 gpm total combined) in an effort to retard contaminant migration.

From the illustration of the various scenario models shown on Figure 3-2, it is evident that plume migration appears to be primarily to the northeast into Little Timber Creek Swamp. If the lagoon level is lowered to the water table, the model shows that contaminant migration is somewhat reduced, although not drastically reduced. Finally, if the lagoon level is lowered and four "scavanger" wells are pumped at 400 gpm, then plume migration still will not be appreciably retarded in comparison to the scenario of only lowering the lagoon level.

It should be noted that the groundwater modeling is based on the available information; therefore, the aforementioned results should be viewed in a relative sense rather than an absolute sense. The actual plume migration may be somewhat different than the migration predicted by this modeling since actual groundwater movement may be affected by a multitude of factors which are either unknown at this time or unaccounted for by the model.

3.2.3 Surface Water/Sediment

The highest contaminant concentrations detected in any surface water sample were for a sample taken northeast of the site in Little Timber Creek Swamp (43 mg/l organic carbon, 4400 mg/l oils, 330 µg/l methylene chloride, and 34 µg/l total PCB). A sediment sample taken from the same location also showed the highest level of contamination with a PCB concentration of 2.5 milligrams per kilogram and an oil and grease content of 27 percent. This contamination in the surface water and sediment northeast of the site appears to be the result of lagoon overflows and dike breaches in this area in the past. The Gaventa and Swindell Ponds, located adjacent to the lagoon, did not show significant contamination, although the threat of contamination in these ponds is great because of their proximity to the BROS lagoon.

There is no doubt that the BROS lagoon poses a threat to the local surface waters and sediments. Currently, direct contaminant migration into local surface waters appears to be the result of breaching or overflowing of the lagoon dikes. Indirect contamination of the local surface waters appears to be the result of contaminated groundwater discharging into these surface water bodies. Fortunately, the swamps surrounding the BROS Site are favorable for the biodegradation of organic contaminants, if the loading is small (with the exception of PCBs which tend to be resistant to biodegradation). Therefore, if these swamps are contaminated, the organic contaminants may biodegrade. PCBs released to surface waters would not tend to migrate with the water since they are immobile and highly insoluble in water and, instead, prefer to stay in the oil phase or adsorb to sediments. However, erosion of sediments or large oil releases could cause PCB migration. A major failure in the lagoon dike would have disastrous effects on the local surface water and sediment--the release of vast quantities of PCB-contaminated oil into the environment. Such a release could also effect the local groundwater by infiltration.

From the available information, it appears as though offsite surface waters and sediments have not been contaminated to a great degree. However, in its present state, the BROS lagoon poses a real and considerable risk to the offsite surface water and sediment. Unless some action is taken with respect to the lagoon, reducing or eliminating the threat to the offsite environment, substantial and potentially irreversible damage to the local environment could occur in the future.

With respect to the offsite surface waters and sediment, the only direct remedial action necessary at this time appears to be a limited-scale surficial cleanup of areas where oily sediments and/or water are observed to be present.

3.2.4 Air

Ambient air monitoring during the NUS Remedial Investigation was limited to monitoring with an organic vapor analyzer. Although volatile organic species were detected in the lagoon, no volatile organic readings above background were observed in the ambient air. However, one potential air contamination problem has been identified, although it has not yet been observed. This air contamination problem is the potential for PCB-laden dust to become airborne and migrate off site. With the potential variability of the lagoon levels, especially if lagoon water is removed and treated by the EMPAK water treatment system, it is possible that the PCB-contaminated lagoon sediment could become exposed to the drying effects of the wind and sun. If this situation should occur, then risks to onsite personnel and offsite individuals could result from windborne, PCB-contaminated, lagoon sediment/dust. However if the lagoon oil partially coats the exposed sediment as the lagoon level fluctuates, then the oil may help prevent any of the sediment from becoming airborne.

3.3 Site Remediation Objectives

From the evaluation of the Remedial Investigation results for the BROS Site, it is apparent that several areas of the site and site vicinity are worthy of consideration for remedial action. Each of these areas is discussed below.

Analyses of the three phases of the BROS lagoon indicate that the lagoon poses a serious threat to the health and welfare of the general public and to the environment. The lagoon oil and sediment are laden with PCBs at concentrations above 500 ppm, as well as other organics, and the lagoon water contains significant concentrations of a variety of HSL organics. Without ongoing lagoon-water treatment, the lagoon level continues to rise from rainwater input, threatening to overflow or breach the existing dikes and thereby causing substantial contamination of the local environment. Furthermore, the lagoon wastes are in contact with the underlying aquifer, which is used for potable water, and there seems to be little doubt that the lagoon is contaminating the groundwater. For these and other reasons, it is obvious that the BROS lagoon deserves consideration for remedial action. Implicit in any subsequently developed lagoon cleanup alternatives will be the surficial cleanup of about one acre of land adjacent to the east-northeast side of the lagoon. This land is covered with a thin layer of oil material that seems to have been deposited by past lagoon overflows and/or dike breaches along this side of the lagoon. This surficial cleanup is expected to be small in scope and cost as compared to the remainder of the lagoon cleanup activities.

The groundwater beneath the BROS Site has demonstrated contamination which seems to be attributable to the lagoon. This groundwater contamination appears to be migrating from the site, although at a slow rate, and appears to have contaminated several residential wells in the immediate vicinity of the site with volatile organics at levels that exceed Federal and State drinking water criteria. For these reasons, this contaminated groundwater and the residential wells that it has (or may) affect deserve consideration for remediation.

Surface water and sediment in the vicinity of the BROS Site have not demonstrated substantial contamination, with the exception of the aforementioned area of visible oil contamination adjacent to the east-northeast side of the lagoon. Since this oil-contaminated area is to be included with lagoon cleanup options, no other local surface waters or sediments are determined to require consideration for remedial action at this time.

From the NUS Remedial Investigation and previous investigations, it is apparent that wastes do remain in at least some of the tanks on the BROS Site. Although the NUS chemical analytical data for these tanks have not yet been received, data from previous reports indicate that the wastes in these tanks may be hazardous. Furthermore, the physical integrity of many of the tanks is questionable. For these reasons the BROS tanks are worthy of consideration for remedial action. This point will be finalized prior to issuance of the final Feasibility Study.

Section 4 of this report presents the preliminary identification of remedial technologies that address the previously discussed cleanup objectives. Also included in Section 4 is the initial screening of these technologies. Section 5 takes the technologies that passed the initial screening and develops them into remedial action alternatives. The developed alternatives are then evaluated and the most cost-effective alternative for the remediation of the BROS Site is selected.

4.0 PRELIMINARY REMEDIAL ALTERNATIVES EVALUATION

This section presents a preliminary identification of remedial action alternatives that may be applicable for cleanup of the Bridgeport Rental and Oil Services (BROS) Site. These alternatives were based upon data developed in a site Remedial Investigation conducted during the summer and fall of 1983 as well as site investigations performed by Camp Dresser and McKee (CDM) prior to 1983. Candidate remedial alternatives were identified early in the project so that the site investigations by NUS could be tailored to provide the necessary information regarding the feasibility of these alternatives. This information provides a basis for the development of detailed alternatives which are environmentally implementable and cost-effective.

4.1 <u>Development and Screening of Remedial Action Technologies</u>

4.1.1 Background

The NCP outlines a three-phased process for the selection of the most appropriate remedial approach for a given site. First, a limited number of remedial action alternatives are identified and developed. Second, an initial screening of feasible technologies is required to reduce the number of alternatives to a workable number by eliminating obviously infeasible, inappropriate, or environmentally unacceptable alternatives. The third phase of remedial action selection involves a detailed analysis of a limited number of remedial alternatives based on technologies that have passed the initial screening stage. This process is required as outlined in Section 300.68 (g), (h) and (i) of the NCP which states:

> (g) Development of Alternatives. A limited number of alternatives should be developed for either source control or offsite remedial actions (or both) depending upon the type of response that has been identified as being appropriate.

(h) Initial Screening of Alternatives. The alternatives developed will be subjected to an initial screening to narrow the list of potential remedial actions for further detailed analysis.

(i) Detailed Analysis of Alternatives. (1) A more detailed evaluation will be conducted of the limited number of alternatives that remain after the initial screening.

Further, the NCP contains three requirements for any corrective action implemented at uncontrolled waste sites. (300.68 (h) (2)):

- The corrective action should not cause a significant adverse environmental impact.

- The action should provide adequate control to keep chemicals on site and prevent offsite migration of chemicals at levels which may have a detrimental or adverse effect.

- The action should mitigate or minimize any threat of harm to public health, welfare, or the environment.

To meet these requirements, the EPA also requires consideration of the following factors as stated in the NCP (300.68 (e) (3)):

- (i) The extent to which chemicals are a danger to public health, welfare, or the environment.

- (ii) The extent of chemical migration.

- (iii) Previous experience in similar situations.

- (iv) Environmental effects and welfare concerns.

The NCP (300.68 (j)) further states that a corrective action supported by "Superfund" shall be the lowest cost alternative that is technologically feasible and reliable.

In addition to the above, it is necessary that at least one alternative fully comply with the technical requirements of other environmental programs.

The full compliance alternative must be included in the detailed evaluation of alternatives and should not be eliminated in the initial screening step. The full-compliance alternative should be compared with the other alternatives that are developed with respect to the requirements of CERCLA (e.g. cost-effective protection of public health, welfare, and the environment). Both cost and effectiveness measures must be evaluated to determine if the full compliance alternative will be recommended.

Specifically, alternatives must be developed to comply with regulations for surface impoundments, waste piles, land treatment, or landfills, as appropriate. The most likely requirements that would apply for onsite alternatives are the technical regulations of the Resource Conservation Recovery Act (RCRA) (40 CFR Parts 264 and 265). Other environmental requirements that must be taken into consideration in the remedial action evaluation process for the BROS Site include:

- Toxic Substances Control Act (TSCA), 40 CFR Part 761, for PCB wastes

- Executive Order 11988, Floodplain Management for sites located in floodplains

- Clean Air Act

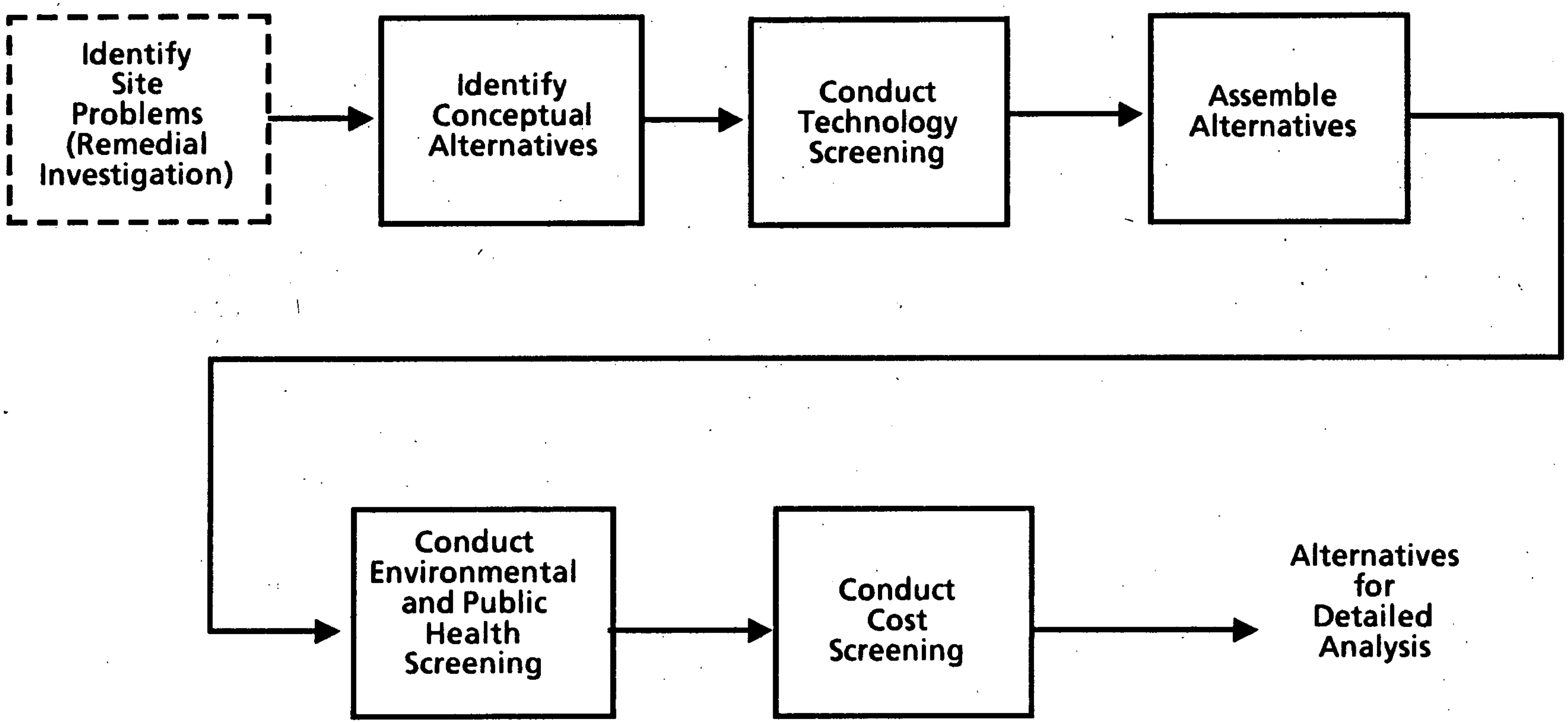

Figure 4-1 Feasibility Study Alternative Development and Screening Process

4.1.2 Overall Approach

A flow chart of the screening and alternative development procedure typically followed is shown in Figure 4-1 and consists functionally of the steps shown in the following:

- Identify problems and pathways of contamination (Remedial Investigation).
- Identify conceptual alternatives which address site problems and meet cleanup goals and objectives.
- Screen technologies comprising each conceptual alternative to eliminate inapplicable and infeasible technologies.
- Assemble alternatives based on the remaining feasible technologies and technology options.
- Screen alternatives in terms of environmental and public health impacts/benefits and eliminate those that pose significant adverse impacts or obviously do not adequately protect the environment, public health, and public welfare.
- Estimate order of magnitude costs and screen expensive alternatives that offer the same or lesser environmental and public health benefits.

The development and initial screening of remedial alternatives is actually an iterative process that may take place at several points in the remedial action evaluation process. The development and screening of alternatives may begin during the Remedial Investigation to better define field data collection requirements related to specific remedial actions. As more site data are developed, existing alternatives may be screened and additional alternatives developed to reflect the improved understanding of site conditions. Screening may also occur during detailed analysis of alternatives if it is determined that an alternative is clearly inferior and should not be considered, or if an additional alternative is developed which is potentially the most cost-effective remedial action.

The alternative development and screening, as discussed in this section, represent a process that is generally done on an informal basis, usually described as "best engineering judgment." A formal procedure is not necessary at this point in the decision-making process.

Remedial actions at hazardous waste disposal sites include a wide spectrum of options to manage the wastes and the potential or actual contamination of groundwater, surface water, soils, and air. Previous remedial action experience has demonstrated the site-specific nature of the various options. No two sites are alike in their waste types and quantities, or in their hydrologic environment. The selected remedial action strategies must reflect the existing site-specific constraints.

Basic information is collected to evaluate potential remedial action strategies. This information includes:

- A characterization of the hydrogeologic conditions at the site, including soil types, groundwater flow patterns and quality, surface water quality, and climatic conditions.

- Knowledge of the waste characteristics, including waste types, compositions, quantities, and past handling practices.

- Understanding of potential and actual environmental impacts associated with the waste site, and evaluation of the potential impacts of remedial actions.

- Identification of the various remedial action technologies and an assessment of their technical feasibility and cost effectiveness at the particular site.

The wide spectrum of remedial action alternatives considered is listed in the following section. Some of these alternatives were eliminated as a result of the analysis and screening procedure that follows. At the end of the preliminary analysis, only those alternatives most feasible are recommended for detailed evaluation.

4.2 Identification of Remedial Action Technologies

This subsection outlines the types of remedial action technologies that are available and identifies potential strategies for implementing remedial action at the BROS Site. For reference, a listing of general response actions and associated remedial technologies is presented in Table 4-1.

For the purpose of this evaluation for the BROS Site, two distinct sources of potential contamination were defined (the tank farm area and the 12.7-acre lagoon), and one potential receptor was identified (the residential wells contiguous to the site). Given this approach, a list of potential strategies for the BROS Site was compiled and is presented in Table 4-2.

After the potential technologies applicable to the remediation of the BROS Site were identified, they were reviewed by representatives of NUS, the EPA Region II, and the Army Corps of Engineers at a technology review meeting. The identified technologies were evaluated with respect to achieving the site-specific objectives for remediation of the BROS Site based on the following criteria:

- Technical feasibility
- Cost effectiveness
- Implementation time frame
- Environmental effectiveness

TABLE 4-1

GENERAL RESPONSE ACTIONS AND ASSOCIATED REMEDIAL TECHNOLOGIES

No Action	- May include some monitoring and analyses
Containment	- Capping, dust control, addition of freeboard, groundwater containment barrier walls, bulkheads, gas barriers
Pumping	- Groundwater pumping, liquid removal, dredging
Collection	- Sedimentation basins, French drains, gas vents, gas collection systems
Diversion	- Grading; dikes and berms; stream diversion ditches and trenches; terraces and benches; chutes and downpipes; levees; seepage basins
Complete Removal	- Tanks, drums, soils, sediments, liquid wastes, contaminated structures, sewers and water pipes
Partial Removal	- Tanks, drums, soils, sediments, liquid wastes
Onsite Treatment	- Incineration; solidification; biological, chemical, and physical treatment
Offsite Treatment	- Incineration; biological, chemical, and physical treatment
In-situ Treatment	- Permeable treatment beds; bioreclamation, soil flushing; neutralization; land farming
Storage	- Temporary storage structures
Offsite Disposal	- Landfills; surface impoundments; land application
Alternative Water	- Bottled water; cisterns; above-ground tanks; deeper or upgradient supply wells; municipal water system; relocation of intake structure; individual treatment devices
Relocation	- Relocation of residents, businesses, and habitat areas

TABLE 4-2

POTENTIAL REMEDIAL ACTION STRATEGIES AT THE BROS SITE

Lagoon

- No Action
- Site Management (lagoon-level control)
- Cap System
- Waste Stabilization with Onsite Storage
- Onsite Encapsulation
- Onsite Incineration
- Passive Groundwater Controls (flow diversion)
- Active Groundwater Controls (flow manipulation)
- Wastewater Treatment
- In-situ Biodegradation of Waste
- Waste Removal with offsite disposal at an Annex I Incinerator
- Waste Stabilization with offsite disposal in an Annex II Chemical Landfill

Tank Farm

- No Action
- Tank Cleaning and Waste Removal
- Tank Demolition and Removal

Residental Wells

- No Action
- Carbon Filtration of Individual Residential Water Supplies
- Alternate Water Supply (pipeline from an existing municipal water system)

Institutional factors and safety considerations that might affect the implementability of an alternative were also considered. This information was then used to identify and screen potential remedial action strategies for the BROS Site.

The results of this comprehensive evaluation process are presented in the following section.

4.3 Initial Screening of Remedial Action Alternatives

4.3.1 Tank Farm

During the conduct of the initial screening, it became clear that the ultimate resolution of the tank farm issue would be directly related to the remedial action selected for the lagoon. For all lagoon remedial actions, excluding no action and site management, the tank farm would have to be demolished and removed from the site to allow sufficient working area at the site to implement the lagoon remediation.

Nevertheless, to document the screening process as it applies only to the tank farm, the following presentation is made. For the sake of ease in analysis, it was assumed that any contract to perform tank farm remediation would be independent of any other site cleanup activities.

- No Action

  General Description

  Under the no action alternative no effort would be initiated to either remove the tank wastes or to demolish and remove the tanks that are located in the onsite tank farm. The only activity under "no action" for the tank farm would be periodic monitoring to assess the physical integrity of the tanks and to observe if leakage of the tank contents is occurring.

Application to the BROS Site

The no-action alternative, with respect to the BROS tank farm, did not pass the initial screening phase because it is inconsistent with RCRA regulations. Under "closure" guidelines set forth in RCRA Part 265, all hazardous waste and hazardous waste residues must be removed from tanks and associated equipment.

- Tank Cleaning and Waste Removal

General Description:

Under this remedial action, tank wastes would be removed from the tanks and properly disposed of, and the tanks would be thoroughly cleaned to remove any residuals. Following cleaning, the tanks would be sealed or patched to reduce the chance of rainwater accumulation. Also, access ladders would be removed and manways would be sealed to reduce the possibility of unauthorized entry into any of the tanks. Wastes removed from the tanks, along with any tank cleaning solutions, would be hauled offsite to appropriate disposal facilities. Also included with the alternative would be the need to perform periodic inspections of the tank farm area to observe whether any tanks were accumulating rainwater or to identify any other potentially dangerous conditions that may be developing.

Application at the BROS Site

Without considering other site cleanup activities, this alternative passed the initial screening since the hazardous wastes in the tanks would be removed from the site, and therefore any threat to the environment, public health, and public welfare from these tank wastes would be reduced.

- Tank Demolition and Removal

General Description:

With this option, the tank wastes would be removed and disposed of, and the tanks would be demolished, removed from the site, and properly disposed of. The issue of the exact approach to implement this option was not given detailed consideration in this analysis since there are many hazardous waste cleanup contractors who have successfully handled similar projects in a manner consistent with environmental regulatory guidelines.

Application at the BROS Site

Since under this action, the wastes in the tanks would be removed from the site, and the tanks would be removed as well (thereby substantially decreasing the threat to the environment, public health, and public welfare), this alternative passed the initial screening. Additional advantages afforded by this alternative include the elimination of any need to conduct periodic inspections of the tank farm and an improvement in the aesthetic qualities of the site.

4.3.2 Lagoon

During the evaluation of remedial action options for the 12.7 acre lagoon, a principal consideration was whether contaminated materials would remain in contact with the groundwater after completion of the particular activity. In the initial screening of lagoon alternatives, those alternatives that, when completed, permitted the hazardous waste in the lagoon (including the oil, aqueous, and contaminated sediment phases) to remain in contact with the groundwater were eliminated from further consideration. These alternatives were eliminated based on the fact that evaluation of the site in accordance with the Hazard Ranking System (contained in Appendix A of the National Oil and Hazardous Substances Contingency Plan, 40 CFR Part 300) would not remove the site from the National Priorities List. Also, the lagoon would be in the 100-year flood plain (i.e., 9.8 feet mean sea level NGVD ~~(MSL)~~ versus site average grade level of approximately 10 feet NGVD ~~MSL)~~. Additionally, under RCRA the lagoon would not comply with the requirements for the location of hazardous waste facilities in a manner to protect human health and the environment. Location of hazardous wastes within the aquifer of concern is unacceptable.

- No Action

<u>General Description</u>

Under the no-action alternative, the lagoon would remain in its present condition. Only periodic monitoring of groundwater and surface water contamination, and visual observations of the lagoon above grade dike wall integrity would be performed. The present treatment plant used to control the aqueous inventory would not be present.

<u>Application at the BROS Site</u>

This option is unacceptable for several reasons. First, without controlling the lagoon inventory, the possibility of dike breaching and/or overtopping could result in widespread environmental damage to the surface soils and surface water bodies contiguous to the site, as well as substantial damage to the Little Timber Creek watershed. Furthermore, such a release resulting from dike failure or overtopping would pose a considerable risk to the health and welfare of the general public. Additionally, under the no-action alternative, the lagoon wastes would remain in contact with the groundwater, a situation which is unacceptable, as previously mentioned.

- Site Management

General Description

For the purpose of this evaluation, site management was considered to include the minimum effort to decrease the risk of breaching and/or overtopping of the lagoon as well as periodic maintenance and chemical monitoring. Since the Army Corps of Engineers has a contractor at the site pumping water out of the lagoon and treating it for discharge to Little Timber Creek, this option is feasible with respect to lagoon inventory control. However, such a system would have to operate ad infinitum to be effective.

Application at the BROS Site

Although treating and discharging the lagoon water is technically feasible, this alternative was screened from further consideration as an overall lagoon remediation alternative because the hazardous substances within the lagoon would remain in contact with the groundwater.

- Cap System

General Description

Under this alternative, a cap system would be designed to reduce the amount of rainwater infiltration through the contaminated areas of the BROS Site, and thereby reduce the potential for subsequent leachate generation and groundwater contamination. The reduction of infiltration can be achieved through "capping" with impervious materials or surface sealing techniques. Many methods exist for capping. These can be generally grouped into the following classes:

- Synthetic membrane
- Low permeability soils
- Asphalt or concrete
- Multilayered cover system

Application at the BROS Site

Infiltration controls, such as synthetic membranes, clay caps, or multilayered covers, would be a medium-cost, relatively short time frame installation alternative at the BROS Site. However, a cap system, in and of itself, cannot be considered a viable option to remediate site contamination problems. Instead it must be considered as an integral part of other lagoon remedial actions, such as waste excavation. Regardless of the lagoon cleanup option finally selected, a capping system may be considered to reduce possible groundwater contamination resulting from precipitation.

- Waste Stabilization with Onsite Storage

In-Situ

General Description

The liquid contents of the lagoon would be removed to the depth of the water table. Chemicals and inert materials such as soil, sand, or fly ash would be mixed with the contaminated lagoon sediment to form an admixture with the structural integrity and chemical characteristics necessary to meet RCRA delisting requirements.

Application at the BROS Site

Although the in-situ waste stabilization technique has been used successfully at some hazardous waste facilities, it would not be acceptable at the BROS Site. A major problem is that the hazardous materials in the lagoon would not be removed from contact with the groundwater. Also, the magnitude of physical effort to successfully blend the chemicals to produce a uniformly inert admixture capable of meeting delisting requirements would be impractical if not impossible. This option was, therefore, screened from further consideration.

Lagoon waste excavation, stabilization, and replacement.

General Description

For this stabilization alternative the same physical/chemical processes would be used to stabilize the waste as would be used for in-situ stabilization. However with this alternative, the waste would be removed from the lagoon, stabilized on shore in a stabilization facility (allowing the waste to be stabilized more uniformly and completely than would be possible with the in-situ case), and then returned to the lagoon. In order to satisfy RCRA requirements (i.e., storing, the stabilized waste above the water table) the contaminated sediment would need to be excavated and stored above ground until the lagoon could be backfilled with clean material to an acceptable elevation above the water table.

Application at the BROS Site

Although in many cases, this alternative would pass the initial screening step, in this case it was eliminated from further consideration at the BROS Site on the basis of difficulty in implementation. The available space at the BROS Site is not sufficient (even if the tanks are removed) to store the lagoon waste while the lagoon is being backfilled to above the water table (not to mention the area needed to set up the stabilization facility and to store the stabilizing agents). Furthermore, this site would normally not be considered as a new storage facility for hazardous waste, based on the unfavorable site geological framework (e.g., sandy soils and high water table). Also, this facility would be in the 100-year flood plain. With this alternative a signficiant reduction in the Hazard Ranking System value for this site would not be realized.

- Onsite Encapsulation

General Description

Under the encapsulation alternative, the lagoon wastes would be excavated and then reburied on site in an encapsulation cell. The component technologies associated with this alternative include:

- Cap system
- Liner system
- Site maintenance and monitoring

The cover and liner system would be designed to contain the wastes in a given area, isolating them from infiltration or groundwater inflow. The cover technologies for encapsulation are the same as those previously discussed for the cap system alternative. The difference lies in the "total isolation" approach of the encapsulation cell. In a secure cell, the cover system is tied into the liner system to create a total seal around the waste.

Side and bottom liners are necessary components of the encapsulation cell. The use of a passive liner system (no leachate collection) constructed of natural or synthetic materials of low permeability is a viable approach to minimizing groundwater inflow to the cell or leachate migration from the cell. A collection system could be included as a component of the liner to contain and collect seepage.

Application at the BROS Site

The onsite encapsulation alternative was screened from further consideration at the BROS Site for much the same reasons as was the waste excavation, stabilization, and reburial alternative. Reiterating, the available area at the BROS Site is insufficient to allow for storage of the excavated lagoon waste while the lagoon pit is being backfilled to an acceptable level and an impermeable liner system is being constructed.

- Incineration

General Description

Onsite high-temperature incineration offers an effective means of destroying PCBs and other organic contaminants. The organic contaminants present in the lagoon oil and sediment can be detoxified in an approved mobile incinerator. Advantages of this alternative include a reduction in transportation costs since only the residual ash from the incinerator needs to be hauled offsite (the ash content of the lagoon waste ranges from about two percent for the oil up to about 70 percent for the sediment). Furthermore, high-temperature incineration seems to be the technology most favored by the EPA for the disposal of materials containing greater than 500 ppm PCB. Appendix A addresses this disposal option in more detail.

Application at the BROS Site

Although securing the necessary permits to incinerate wastes on site was recognized as a potential drawback, the decision was made to give this alternative further detailed evaluation. This decision was based on the assumption that the intervening period between the selection of a remedial action and the actual initiation of site cleanup activities will be on the order of 2 years, which should be sufficient time to secure permission to incinerate the BROS lagoon wastes on site using an approved mobile incinerator. Furthermore, the cost savings that can be realized by incinerating wastes at the site are substantial in comparison with some offsite disposal options.

- Passive Groundwater Controls (Flow Diversion)

General Description

Various technologies are available to provide passive groundwater control of contaminant migration. Flow diversion is designed as a method to isolate the contaminated area so as to reduce groundwater migration from the site. The passive groundwater control that could be applicable to the BROS Site would be the use of cut-off walls.

Cut-Off Walls

A subsurface cut-off wall is designed to divert groundwater flow. The technique requires that an impermeable barrier extend below grade so as to intercept and cut off groundwater either entering or leaving a particular site. Typically, the impermeable barrier or cut-off wall would extend and key into the confining or semiconfining strata underlying the site. However, this is not always necessary, and, depending on the hydrogeologic conditions, partial cut-off walls can be an effective means of containing the migration of contaminants from a site.

The principal benefit of subsurface cut-off walls is the restricted potential for leachate migration in subsurface pathways where the primary mechanism of dispersion is groundwater flow. A second major benefit is that cut-off walls are normally constructed in an encompassing fashion; that is, not only do flow barriers restrict groundwater outflow from a site, but they also restrict groundwater inflow to the site when constructed up-gradient from the site.

Depending upon the geologic conditions, the depth of penetration of a cut-off wall can vary from as little as several feet to in excess of 100 feet below ground surface. To a large extent, the depth of penetration will dictate the technique which is ultimately employed in the cut-off wall construction. Cut-off walls may be constructed using one of the following materials or methods:

- Compacted clay
- Synthetic membranes
- Slurry trench techniques using bentonite or other natural or synthetic materials
- Grout curtains
- Sheet piling
- Chemical injection
- Electro osmosis
- Ground freezing

Application at the BROS Site

Passive groundwater flow systems (cut-off walls) were eliminated from further consideration as potential remedial actions at the BROS Site for a number of reasons. Cut-off walls were eliminated because the confining layer is at a depth (100 to 140 feet) that begins to be prohibitive for installation. Also, the site layout, especially the presence of dikes around much of the lagoon, would make it difficult, if not impossible, to construct cut-off walls around the lagoon without also surrounding the Gaventa and Swindell Ponds. Also, the presence of swamps in the surrounding area would make it difficult to construct cut-off walls since the heavy equipment used to install the walls would tend to sink into the soft, swampy earth unless suitable subgrade support (which can be very expensive) is provided. In general, passive groundwater control systems would be difficult and expensive to implement at the BROS Site.

- Active Groundwater Controls (Flow Manipulation)

General Description

Active groundwater control techniques rely upon the alteration or manipulation of groundwater flow patterns. Groundwater extraction was considered as the only viable flow manipulation technique that would be applicable at the BROS Site.

Groundwater extraction methods create a cone of depression in the zone of saturation. The intent of groundwater withdrawals is to lower the static water level, thereby reducing the hydraulic gradient and the flow through the contaminated area. Active groundwater extraction techniques include the following technologies:

- French drains
- Collection sumps and pumps
- Deep or shallow extraction wells (large and small diameter)
- Collection galleries (well points)
- Vertical sand drains

Application at the BROS Site

As with the passive groundwater control alternatives, active groundwater control systems were eliminated from further consideration at the BROS Site on the basis of lack of effectiveness and difficulty in implementation because of the general site conditions and geology. Groundwater extraction systems failed the initial screening because the aquifer characteristics are such that an enormous amount of water would need to be withdrawn in order to lower the static water table to the point where it no longer contacted the lagoon wastes. Furthermore, such a massive withdrawal could cause serious problems in the locality, including destabilizing roads and foundations, and flooding of the discharge receptor (i.e., Little Timber Creek). In addition, consideration was given to the possibility of selectively pumping the plumes of contaminated groundwater with the objective of removing the plumes. This groundwater extraction approach would be necessary to fulfill the "full compliance" alternative at the site since plumes of contaminated groundwater are hazardous waste as defined by RCRA. Nevertheless, as discussed in Section 3.2.2, groundwater modeling of the aquifer beneath the BROS Site has estimated that groundwater extraction rates in excess of 20 million gallons per day may be needed over a 5-year period in order to extract the contaminated groundwater. The model also indicated that groundwater extraction at more reasonable rates (i.e., 500,000 gallons per day) would probably have only a small effect on decreasing the plume migration. Section 3.2.2 and Appendix B discuss this modeling in greater detail.

- Wastewater Treatment

General Description

Numerous wastewater treatment/disposal options are available for application to site-specific problems. Wastewater treatment technologies are well established, and have a high degree of confidence. There are basically three major functions of groundwater/wastewater treatment operations:

- Destruction
- Volume reduction
- Stabilization

Destruction techniques attempt to detoxify wastewater using chemical, physical, or thermal processes. Volume reduction techniques are designed to reduce the quantity of wastewater to be disposed. Using volume reduction, wastewater toxicity is not eliminated, but it becomes more concentrated. Stabilization processes are usually chemical techniques designed to stabilize the wastewater for disposal.

Application at the BROS Site

Possible applications for wastewater treatment at the BROS Site include the treatment of the contaminated lagoon water and the treatment of any extracted groundwater. Since wastewater treatment technologies are well established and effective in reducing contaminant levels in water, and since the water treatment facility that is presently on site has demonstrated effective treatment of the lagoon water, this technology has passed the initial screening phase. However, this technology would need to be combined with other remedial actions to form an overall effective action since this technology does not address the lagoon oil or sediment. Also, because the groundwater extraction technologies were previously screened from further consideration, wastewater treatment is not applicable to groundwater treatment at the BROS Site. In the subsequent detailed evaluation of alternatives, both onsite water treatment (i.e., a system similar to EMPAK's facility that is currently at the site) and offsite water treatment (i.e., hauling water to an industrial wastewater treatment facility) will be considered.

- In-Situ Biodegration of Waste

General Description

Biodegradation of waste as an alternative involves the employment of a mutant strain of bacteria to metabolize and thereby destroy or detoxify the organic contaminants. This method of remediation has been found to be effective for oil spills, lagoon cleanups, and other hazardous waste applications. For effective microbial activity to occur, the proper strain of bacteria must be selected, an adequate and balanced supply of nutrients must be available (generally the oily waste with added nitrogen and/or phosphorus), and the system to be biodegraded must be aerated. Biodegradation in the chemical environment of the BROS lagoon would take several years before significant reduction in contamination occurs.

Application at the BROS Site

Biodegration of wastes in the BROS lagoon was eliminated from further consideration as a remedial action. Current research indicates that no specific microorganism has been discovered that will effectively oxidize or degrade highly chlorinated biphenyls, which are the contaminant of primary concern in the BROS lagoon (conversation with Albert Klee, EPA Research Labs, Cincinnati, Ohio, March 1984). Reinforcing this research is a study conducted by CDM on the bio-oxidation of the BROS lagoon wastes. CDM reported in their study that rates of bio-oxidation of the lagoon wastes were very slow and evidence of bacterial acclimation to the wastes was not observed. Furthermore, the aeration that would be required for biodegradation could disturb the semi-impermeable layer of oil, sediments, and sludge that is believed to exist at the bottom of the lagoon. If this semi-impermeable layer is physically disturbed, then increased percolation of the lagoon contents into the groundwater is likely to occur.

- Waste Removal with Offsite Disposal at an Approved Incinerator

General Description

Under this alternative the lagoon oil and/or the lagoon sediment would be removed from the lagoon and hauled offsite to an approved PCB-incinerator. Potential offsite incinerators include SCA Services (Chicago, Illinois), ENSCO (El Dorado, Arkansas), At-Sea-Incineration (Philadelphia, Pennsylvania), and Rollins (Deer Park, Texas). Appendix A of this report discussses this alternative in more detail.

Application at the BROS Site

Removal of lagoon waste and transporting it to an approved, offsite incineration facility is a well-established and commonly used action. Furthermore, the EPA indicated that incineration seems to be the disposal method of choice for the disposal of PCB-contaminated materials. Therefore, this alternative passed the initial screening phase for the BROS Site.

- Waste Stabilization with Offsite Disposal in an Approved Chemical Waste Landfill

General Description

This technology involves removing the lagoon oil and/or sediment from the lagoon and mixing it with chemicals and inert materials to form an admixture that contains no free liquids and has a load-bearing capacity of at least 150 pounds per square foot. The stabilized material would then be hauled off site to an approved chemical waste landfill for disposal. This alternative is discussed in greater detail in Appendix A.

Application at the BROS Site

As discussed in Appendix A, it is unacceptable to stabilize a nonsolid material containing greater than 500 ppm PCB into a solid material for the purpose of landfilling the waste. Therefore, on this basis, stabilization of the oil and/or sediment may not be permitted depending on the final ruling as to whether these wastes contain greater than 500 ppm PCB. Since the oil has consistently shown PCB levels above 500 ppm, stabilization of the oil phase has been removed from further consideration. However, the sludge has shown substantial variability in its PCB contamination, especially for the Treatability Study analyses presented in Appendix A. Therefore, stabilization of the sludge with offsite landfilling of the stabilized material has been retained for further consideration contingent upon the fact that the sediment, or at least part of it, will be classified as containing less than 500 ppm PCB.

4.3.3 Residential Wells

From the Remedial Investigation results and the results from the EPA residential well sampling program, it is apparent that domestic wells in the vicinity of the site are presently contaminated or may become contaminated. As indicated in the groundwater discusssion in Section 3.2.2, ten domestic wells in the vicinity of the BROS Site have been contaminated or may reasonably be assumed to be in danger of contamination as a result of the conditions at the BROS Site. Therefore, any action with respect to the residential wells will be scoped on the basis of addressing the following wells: Keller (Van Scoy), Pepper Industries, Fish Diesel Repair, Byrnes, Lindle, Cahill, Newton, Fryberger, Hillman, and Bell. The Pepper Industries well and the Fish Diesel Repair well may not be used for domestic purposes; nonetheless, these wells were still included for the scoping of residential well actions. Wells other than the aforementioned that have demonstrated contamination are not included in this action because, as discussed in Section 3.2.2, these wells appear to have been contaminated by some source other than the BROS Site.

- No Action

<u>General Description:</u>

The no-action alternative, with respect to the residential wells, would involve doing only periodic water sampling and analysis at the domestic wells and possibly at some selected monitoring wells. The results from these analysis would be used to regularly evaluate whether a health risk to the well users was developing. If a health risk is identified, then some other action would be required.

Application at the BROS Site

The no-action alternative for the residential wells passed the initial screening on the basis that five of the ten wells have demonstrated no contamination, and three of the ten wells have shown low levels of volatile organic contamination that do not exceed accepted drinking water standards. Of the two remaining wells, it is uncertain whether the Pepper Industries well is used, and the Keller well currently has a carbon filtration unit that appears to be performing adequately. For the BROS Site, the no-action alternative with respect to the residential wells will also include periodic changing of the carbon in the carbon filtration unit that has already been installed on the Keller well.

- Carbon Filtration of Individual Residential Wells

General Description

This residential well alternative would involve installing an activated carbon adsorption unit on each individual domestic well. Carbon adsorption is a well established and effective means of removing organic contaminants from drinking water. Also included with this alternative would be periodic monitoring of each residential well before and after the carbon filtration unit to assure that the carbon is not becoming exhausted, and to replace the carbon on a regular basis.

Application at the BROS Site

Providing carbon filtration units for each residential well passed the initial screening because it is a well-established technology and has been demonstrated to be effective in removing the contaminants specific to the groundwater in the vicinity of the BROS Site (as is evidenced by the results for the carbon filtration unit installed on the Keller well).

- Alternate Water Supply

General Description

Providing an alternate water supply to residents with contaminated wells is a well-established and common technology. This alternative involves extending a pipeline from a nearby municipal water system to the affected residents and thus replacing their contaminated water supply with a municipal water system hookup.

Application at the BROS Site

Providing an alternate water supply passed the initial screening for several reasons. This alternative effectively alleviates the contamination problem, does not require periodic monitoring at each home, and is technically feasible and implementable. The Pennsgrove Water Supply system is located nearby and would be capable of supplying water to the affected residents, assuming that the necessary improvements to the Pennsgrove System are implemented, as stated in an Administrative Order issued to the Pennsgrove Water Supply Company by the New Jersey Division of Water Resources in December 1981.

4.4 Summary of Initial Screening Results

Using the screening process previously discussed, the preliminary remedial technologies that were originally identified were reduced to a more workable number of technologies that are feasible and applicable to the BROS Site. In Section 5 of this report these technologies are evaluated in terms of this cost-effectiveness and are combined with other technologies in order to develop the most cost-effective remedial action for the BROS Site.

The following list presents the technologies that passed the initial screening phase. These technologies are categorized into groups according to which site problems the technology addresses (i.e., lagoon, tank farm, residential wells). Furthermore, the lagoon technologies are further categorized into groups depending upon with which phase of the lagoon cleanup the technology is involved (e.g., waste disposal, waste removal, site closure). The technologies that are determined to be the most cost-effective in each category will then be combined to form the overall cost-effective alternative for the BROS Site.

- Lagoon

  Waste Disposal - Oil

  - Onsite incineration
  - Offsite incineration

  Waste Disposal - Sediment

  - Onsite incineration
  - Offsite incineration
  - Stabilize and landfill offsite (if less than 500 ppm PCB).

  Waste Disposal - Water

  - Onsite treatment
  - Offsite treatment

  Lagoon Waste Removal

  - Remove oil (pump), remove aqueous phase (pump), dredge sediments (dragline, Sauerman Dredge).

  - Remove aqueous phase (pump), dredge oil and sediment (dragline, Sauerman Dredge).

<u>Closure</u>

- Backfill lagoon to above the water table and revegetate with a provision for surface water runoff to discharge to Little Timber Creek.

- Regrade and revegetate lagoon sides, allow lagoon to remain as a pond (similar to the Swindell and Gaventa Ponds).

- Tank Farm

  - Tank cleaning and waste removal
  - Tank demolition and removal

- Residential Wells

  - No action/monitoring
  - Carbon filtration of individual wells
  - Alternate water supply (pipeline from Pennsgrove Water Supply Company)

5.0 EVALUATION OF ALTERNATIVES

5.1 Methodology for Evaluation of Alternatives

After completion of the initial screening of technologies, a detailed evaluation of technologies was conducted in order to recommend a cost-effective alternative. The cost-effective alternative is the lowest cost alternative that is technologically feasible and reliable and which effectively mitigates or minimizes damage to and provides adequate protection of public health, welfare, and the environment (National Contingency Plan).

Each of the technology groupings identified in Section 4.4 were evaluated in terms of cost and effectiveness. The most cost-effective technologies from each of these categories were then combined to form the overall recommended remedial action for the BROS Site.

5.2 Criteria for Evaluation of Alternatives

5.2.1 Effectiveness Measures

The critical components of effectiveness measures were selected to be technical feasibility as well as public health, institutional, and environmental effects. Particular emphasis was placed on the following:

- Technical Feasibility
  - Proven or experimental technology
  - Risk of failure

- Public health effects
  - Reduction of health and environmental impacts
  - Degree of cleanup

- Institutional effects
  - Legal requirements, institutional requirements
  - Community impacts
  - Approval of land use

- Environmental effects
  - Impact of failure
  - Length of time required for cleanup
  - Amount of environmental contamination with respect to acceptable levels

Based on these components, a set of independent "effectiveness measures" were synthesized, as follows:

- Technology Status
- Risk and Effect of Failure
- Level of Cleanup/Isolation Achievable
- Ability to Minimize Community Impacts
- Ability to Meet Relevant Public Health & Environmental Criteria
- Ability to Meet Legal and Institutional Requirements
- Time Required to Achieve Cleanup/Isolation
- Acceptability of Land Use After Action

5.2.1.1 Technology Status

Technologies involved in a remedial alternative are either proven, widely used, or experimental when applied to uncontrolled hazardous waste sites. Generally, a proven and widely used technology is to be rated highest, and experimental technologies lower. For some specific pollution problems, the only technology available for use at uncontrolled sites may be in the experimental stage. In such a case, an experimental technology may be chosen as cost-effective if it is highly rated with respect to the other effectiveness measures.

Special attention should be paid to whether experience in other less demanding situations is applicable to a remedial action situation.[1]

5.2.1.2 Risk and Effect of Failure

The risk factor is the product of the probability of failure and the consequences of such a failure. A high risk is associated with high probability of failure and significant impacts. Alternatives with a low probability of failure and relatively minor potential impacts resulting from failure are considered low-risk alternatives.[1]

5.2.1.3 Level of Cleanup/Isolation Achievable

In the context of this methodology, cleanup implies that pollutants are removed from the site and/or the environment by the remedial action alternative. Isolation means that the transport of pollutants from the site to the environment is stopped or slowed.[1]

5.2.1.4 Ability to Minimize Community Impacts

A community impact is broadly defined as any change in the normal way of life which can be directly or indirectly attributed to the execution of the remedial action. These changes include those actions which people would not normally undertake, such as moving permanently from a condemned property, moving to temporary lodging during the remedial action, undergoing health monitoring, organizing citizens' groups to review the remedial action, seeking legal advice, and attending public meetings.[1]

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1 This definition has been extracted from a methodology manual entitled Evaluating Cost-Effectiveness of Remedial Actions of Uncontrolled Hazardous Waste Sites produced by the Radian Corporation, Austin, Texas, in 1983.

The above impacts are in some cases merely a source of irritation to a community. However, some possible community impacts are clearly negative, such as increased noise during the action, traffic congestion, loss of access to the site or to roads near the site, decline in property values, and stress related to all of the above and to uncertainty about health risks.[1]

5.2.1.5 Ability to Meet Relevant Public Health and Environmental Criteria

This measure compares the remedial alternatives in terms of how well they attain relevant public health and environmental standards such as those under the Safe Drinking Water Act, Clean Water Act, or Clean Air Act. Alternatives would be compared on level of attainment rather than just attainment or non-attainment.[1]

5.2.1.6 Ability to Meet Legal and Institutional Requirements

This measure assesses the requirements of a given remedial measure for local, State, and Federal permits, and the suitability of the measure to meet other pertinent legal requirements.

5.2.1.7 Time Required to Achieve Cleanup/Isolation

The time required for a remedial action alternative to achieve its designed degree of cleanup or isolation may range from weeks to many years, depending on the technology and site conditions.[1]

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1 This definition has been extracted from a methodology manual entitled Evaluating Cost-Effectiveness of Remedial Actions of Uncontrolled Hazardous Waste Sites produced by the Radian Corporation, Austin, Texas, in 1983.

5.2.1.8 Acceptability of Land Use After Action

This measure assesses the potential for quality land use after completion of the remedial action.

5.2.2 Costs

According to the National Contingency Plan, a total cost estimate for a remedial action must include both construction costs and annual operation and maintenance costs. The Total Construction Cost can be defined as the sum of the Total Direct Capital Cost and the Total Indirect Capital Cost (Radian Corporation, January 1983).

The following definitions have been extracted from a draft Superfund Feasibility Study Guidance Document compiled by JRB Associates, McLean, Virginia, 1983.

Direct capital costs may include the following cost components:

Construction Costs - Components include equipment, labor (including fringe benefits and workman's compensation), and materials required to install a remedial action.

Equipment Costs - In addition to the construction equipment cost component, remedial action and service equipment should be included.

Land and Site Development - Costs include land-related expenses associated with purchase of land and development of existing property.

Buildings and Services - Costs include process and non-process buildings and utility hook-ups.

Indirect Capital Costs may include the following components:

Engineering Expenses - Components will include administration, design, construction supervision, drafting, and testing of remedial action alternatives.

Legal Fees and License/Permit Costs - Components will include administrative and technical costs necessary to retain licenses and permits for facility installation and operation.

Relocation Expenses - Relocation expenses should include costs for temporary or permanent accommodations for affected nearby residents.

Start-up and Shake-down Costs - Costs incurred during remedial action start-up for long-term activities should be included.

Contingency Allowances - Contingency allowances should correlate with the reliability of estimated costs and experience with the remedial action technology.

The operation and maintenance cost may include the following components:

Operating labor costs - Include all wages, salaries, training, overhead, and fringe benefits associated with the labor needed for post-construction operations.

Maintenance materials and labor costs - Include the costs for labor, parts, and other materials required to perform routine maintenance of facilities and equipment for the remedial alternative.

Auxiliary materials and energy - Include such items as chemicals and electricity needed for treatment plant operations, water and sewer service, and fuel costs.

Purchased services - Include such items as sampling costs, laboratory fees, and professional services for which the need can be predicted.

Disposal costs - Costs should include transportation and disposal of any waste materials, such as treatment plant residues, generated during remedial operations.

Administrative costs - Cover all other O&M costs, including labor-related costs not included under that category.

Insurance, taxes, and licensing costs - Include such items as: liability and sudden and accidental insurance, real estate taxes on purchased land or right-of-way, licensing fees for certain technologies, and permit renewal and reporting costs.

Maintenance reserve and contingency funds - Represent annual payments into escrow funds to cover anticipated replacement or rebuilding of equipment and any large, unanticipated O&M costs, respectively.

Construction costs and operation and maintenance costs were estimated for the above criteria. For operating and maintenance costs, a "present-value" analysis was used to convert the annual costs to an equivalent single value. Operation and maintenance costs were considered over a 30 year period; a 10 percent discount rate and 0 percent inflation rate were assumed.

5.3 Evaluation of Alternatives

This section presents an examination and evaluation of the remaining alternatives with respect to cost and the effectiveness measures previously discussed. Each of the technologies that have passed the initial screening were grouped into categories depending on which site problem they addressed (i.e., lagoon, tanks, residential wells). The lagoon category was further subdivided into groups pertaining to various phases of the lagoon cleanup (i.e., waste disposal, waste removal, and site closure). Based on the evaluation that is to follow, the technologies that are selected to be the most cost-effective in each category will be combined to form the overall recommended remedial action with respect to the BROS Site.

5.3.1 Lagoon

As previously mentioned, each of the technologies that passed the initial screening for the remediation of the BROS lagoon were grouped into a category based on which aspect of the lagoon cleanup the technology addressed. Each of these categories (waste disposal--oil; waste disposal--sediment; waste disposal--water; waste removal; and site closure) will be evaluated separately, with the exception of waste removal, which is dependent on the selected disposal method, in order to determine the most cost-effective alternative in each category. The chosen technologies from each category will then be combined to form the overall cost-effective action with respect to the lagoon.

5.3.1.1 Waste Disposal--Oil

The methods which have passed the initial screening for the disposal of the lagoon oil are:

- Onsite incineration
- Offsite incineration

General Description

Each of these oil disposal options is discussed in detail in Appendix A. A brief description of each is presented below.

Onsite Incineration:

Onsite incineration of the lagoon oil would involve transporting and setting up a mobile incinerator on the site to incinerate the lagoon oil. Included with this technology would be the need to have laboratory facilities present at the site to review whether the established effluent guidelines are being satisfied. Also included would be the need to properly dispose of the residual ash produced from the incineration of the oil. At least one commercial firm (Pyrotech System, Inc.) has a mobile incinerator that is licensed under TSCA to incinerate PCB-contaminated materials. Pyrotech is also in the process of building several more mobile incinerators in the hope of having these incinerators licensed to incinerate

PCB articles as well. The subsequent evaluations for the disposal of the oil will use information gathered with respect to the Pyrotech mobile incinerator.

Offsite Incineration:

Offsite incineration of the lagoon oil would involve hauling the oil to an approved incinerator that is licensed to handle PCB wastes. The oil would then be incinerated and the residual ash would be disposed of as required by law.

Evaluation of Oil Disposal Options

Technology Status:

On the basis of technology status, both onsite and offsite incineration are roughly equivalent. Both technologies are approved by the EPA to handle PCB wastes and both options use roughly the same incineration technologies. The only real difference is that the onsite incinerator is a smaller unit and is able to be moved from one site to another while the offsite incinerator must remain stationary. Because the onsite incinerator is smaller than the offsite incinerators, it does incinerate at a slower rate.

Risk and Effect of Failure:

Since the technologies used for the onsite and offsite incineration options are virtually the same, the risk of failure for each option should also be roughly the same. The effect of failure in each case (i.e., incomplete combustion of the wastes with noxious discharges to the atmosphere) would also be roughly equivalent, depending on where the offsite incinerator is located. For example, a failure at the SCA incinerator near Chicago, Illinois, would possibly have a greater effect than a failure with an onsite incinerator, since the Bridgeport area has a low population density relative to Chicago. On the other hand, incineration of the oil at sea (At-Sea-Incineration, Inc.) would have less of an effect in the event of a failure than onsite incineration. Each of the incineration technologies is roughly equivalent in terms of risk and effect of failure.

One area in which onsite incineration would pose less of a risk than offsite incineration would be transportation. In the onsite incineration case, only the residual ash (about 2 percent by weight of the oil) would need to be hauled over-the-road. However, for offsite incineration, all of the oil would need to transported over-the-road rather than just the residual ash. Furthermore, the raw oil is considered to be more toxic than the residual ash in the event of a spill during hauling. When one considers the transportation risk, the onsite incineration option poses less of a risk than offsite incineration.

Level of Cleanup/Isolation Achievable:

The level of cleanup/isolation achievable under onsite incineration and offsite incineration is equivalent since both options use the same method to destroy the contaminants in the oil, and in both cases the oil no longer remains at the site.

Ability to Minimize Community Impacts:

With respect to the actual site work interfering with the everyday activities of the general public, both offsite and onsite incineration are roughly equal. Even though offsite incineration would require that substantially more trucks enter and leave the site for the hauling of the oil, the site is very close to the entrance of a major highway; therefore, hauling vehicles would not need to travel through the local community.

One area in which onsite incineration may be more unfavorable than offsite incineration is with respect to public sentiments. It is possible that the local community will consider onsite incineration unfavorably and will strongly favor offsite incineration instead.

Ability to Meet Relevant Public Health and Environmental Criteria:

Onsite and offsite incineration are roughly equivalent in their ability to meet public health and environmental criteria since each option uses the same basic technology.

Ability to Meet Legal and Institutional Requirements:

Offsite incineration would be rated more favorably than onsite incineration in terms of legal and institutional requirements since the offsite incinerator to be used would already be permitted to incinerate PCB wastes. Onsite incineration, on the other hand, would need to be permitted to operate in the State of New Jersey even though it is already permitted under TSCA. Depending on the sentiments of the State and the results from any test burns for the onsite incinerator, the time to obtain the necessary permits could take 6 months or more. Since the time period between the selection of an alternative and the initiation of site cleanup activities is expected to be about 2 years, it is possible that the onsite incinerator could be permitted without delaying site activities.

Has this matter been investigated with the NJDE

Time Required to Achieve Cleanup/Isolation:

The time required to incinerate the lagoon oil on site (2 to 3 million gallons) is expected to take between 150 and 250 days. This estimate is based on continuous operation, assuming 10,000 BTU/pound of oil and a throughput rate (supplied by Pryotech) of 40 million BTU/hour for the onsite incinerator.

The time required to incinerate the lagoon oil offsite could be somewhat less than onsite incineration since the stationary, offsite incinerators generally have a higher throughput rate. However, difficulties in scheduling offsite incinerators to treat the oil may significantly influence how rapidly the oil can be hauled from the site.

Should be a definitive statement based upon the known capacity

It is difficult to select which incineration option would be faster. The time required for onsite incineration could be decreased by using two or more mobile

Should be definitive statement based upon actual capacity incinerators. Offsite incineration could be accelerated by sending the oil to a number of incineration facilities. Arbitrary — where are these facilities located.

Acceptability of Land Use After Action:

Neither disposal option affects land use after the action. needs elaboration

Costs:

The costs for either onsite or offsite incineration are discussed and developed in detail in Appendix A. The costs include incineration costs, hauling costs, and ash disposal costs. Mobilization and permitting costs are also included for the onsite incineration case; however, these costs are relatively insignificant with respect to the overall disposal cost. Onsite incineration assumes the Pyrotech mobile incinerator or an equivalent incinerator will be used; offsite incineration assumes that the oil will be incinerated at ENSCO in El Dorado, Arkansas or SCA in Chicago, Illinois, since the costs are about the same for each of these offsite incinerators. The costs presented below do not include removal of the oil from the lagoon. incinerator

Method	Cost (Millions of Dollars)	
	2×10^6 gal	3×10^6 gal
Onsite incineration - oil	1.93	2.90
Offsite incineration - oil	6.92	10.4

Recommendation for Oil Disposal:

From the previous discussion, onsite incineration and offsite incineration are relatively equivalent in terms of technology status, level of isolation/cleanup achievable, ability to meet public health and environmental criteria, and acceptability of land use after the action. Onsite incineration was slightly favored in risk and effect of failure, while offsite incineration was significantly favored in ability to minimize community impacts and ability to meet legal and institutional requirements. Time to achieve cleanup/isolation was not a viable discriminant.

In terms of cost, offsite incineration is estimated to be from 3 to 4 times more expensive than onsite incineration, with the potential savings to the government being from 4 to 7 million dollars if onsite incineration is used.

Onsite incineration is recommended for the incineration of the lagoon oil. Onsite incineration can offer substantial savings over offsite incineration without compromising safety or the level of cleanup/isolation achievable. Although onsite incineration was less favorable than offsite incineration in terms of public acceptance and permitting requirements, it is felt that each of these potential problems can be resolved, in which case onsite incineration can be used at the site.

5.3.1.2 Waste Disposal--Sediment

The methods that have passed the initial screening for the disposal of the lagoon sediment are as follows:

- Onsite incineration
- Offsite incineration
- Stabilization and Landfilling

General Description

Each of the sediment disposal options is discussed in greater detail in Appendix A. A brief description of each option is presented below:

Onsite Incineration:

This technology is essentially the same as for lagoon oil disposal since the same mobile incinerator could incinerate both the oil and the sediment. The only major difference is that substantially more ash will be generated for sediment incineration since the sediment contains up to 70 percent ash, whereas the oil contains only about 2 percent ash, based on analyses performed during the Treatability Study. The results of these analyses are presented in Tables A-2 and A-3 in Appendix A.

Offsite Incineration:

Offsite incineration of the lagoon sediment is also virtually the same as for the lagoon oil. All of the same incineration facilities applicable to the oil could also incinerate the sediment, with the one exception of At-Sea-Incineration, Inc., which cannot accept wastes with high solids content.

Stabilization and Landfilling:

Under this disposal option, the lagoon sediment would be removed from the lagoon, stabilized on site in a stabilization facility, and hauled to an approved chemical waste landfill. This alternative can only be used if the sediment is categorized as containing less than 500 ppm PCB; otherwise the sediment would require incineration because it is a nonsolid at present, and nonsolids containing greater than 500 ppm PCB cannot be stabilized into solids for the purpose of landfilling. The only exception would be if the EPA Regional Administrator granted special permission--an unlikely occurrence. If the sediment is deemed to contain less than 500 ppm PCB, then it could be landfilled if it is stabilized so as to contain no free liquids and to have a local bearing capacity of 150 pounds per square foot.

Evaluation of Sediment Disposal Options

Since onsite incineration and offsite incineration compare similarly for disposal of the sediment as for disposal of the oil, it is assumed that onsite incineration would be recommended over offsite incineration for the sediment based on the same reasoning put forth in the oil disposal discussion. Consequently, in the following discussion for sediment disposal, waste stabilization and landfilling will be compared only to onsite incineration.

Technology Status:

The technology status of onsite incineration and stabilization and landfilling are roughly equivalent since both options are well established technologies and are acceptable to the EPA, assuming that the sediment contains less than 500 ppm PCB.

Risk and Effect of Failure:

The risk associated with onsite incineration is believed to be slightly greater than for stabilization and landfilling. The incineration process is more complex than stabilization and would therefore have a higher possibility of failure. Nevertheless, constant monitoring of the incineration process would minimize this risk.

In the event of failure, stabilization and landfilling is expected to have less of an effect than incineration. Failure with respect to landfilling would mean leaching of hazardous materials from the stabilized waste; these leached materials would presumably be collected by a leachate collection system at the landfill. Failure with respect to incineration, on the other hand, could result in the discharge of noxious materials to the atmosphere.

In terms of transportation, the risk and effect of failure in either disposal case would be similar, although possibly more risky for stabilization and landfilling since roughly twice as much material would need to be hauled. The effect of failure (i.e., a spill during transportation) would be similar for onsite incineration and stabilization and landfilling because in each case, the material being handled (ash vs. stabilized waste) would be a solid and would be relatively easy to clean up as compared to liquids. The exception would be if the material were spilled in such a way so as to be irretrievable (e.g., in a surface water body). In that case, the stabilized sediment would be more hazardous since it would still contain PCBs, whereas the incineration ash would not.

Level of Cleanup/Isolation Achievable:

The level of cleanup/isolation achievable under onsite incineration and stabilization and landfilling is the same, since in each case, the sediment would no longer remain on site. Overall, however, onsite incineration may be slightly favored because the hazardous organic constituents of the sediment would be destroyed, whereas for stabilization and landfilling these hazardous constituents are only moved to a more secure environment.

Ability to Minimize Community Impacts:

Onsite incineration would be ranked slightly lower than stabilization and removal with respect to community impacts.

Community impacts from transportation of the stabilized waste on the ash would probably be negligible since a major highway is easily accessed from the site and hauling vehicles would not need to travel through much of the local community.

Ability to Meet Relevant Public Health and Environmental Criteria:

Onsite incineration is slightly favored over stabilization and landfilling in its ability to meet public health and environmental criteria. This determination is based on the fact that the sediment must contain less than 500 ppm PCB to qualify for stabilization and landfilling. Becaues of the variability in the observed PCB levels in the sediment, the possibility exists that at least some sediment containing greater than 500 ppm PCB could be stabilized, a situation that would violate environmental regulations. On the other hand, onsite incineration can meet environmental criteria regardless of the PCB content of the sediment.

Ability to Meet Legal and Institutional Requirements:

Sediment stabilization and landfilling is slightly favored over onsite incineration because of the permits that would be required for the onsite incinerator.

Nevertheless, as previously stated in the oil disposal discussion, the expected time period between the selection of a remedial action and the initiation of the action (about 2 years) is believed to be sufficient to secure the necessary permits for onsite incineration. Also, there may be some difficulty in receiving permission to stabilize and landfill the sediment, and if this permission cannot be received, then stabilization and landfilling would not be implementable.

Time Required to Achieve Cleanup/Isolation:

The time required for incineration of the sediment on site is expected to be slightly longer then the time required to stabilize and landfill the sediment. Incineration on site is expected to take from 100 to 200 days, while stabilization and landfilling may take only 30 to 60 days. However, the stabilization and landfilling procedure may be limited by the speed at which the sediment is removed from the lagoon. Also, the onsite incineration could be accelerated by using two or more mobile incinerators.

Acceptability of Land Use After Action:

For both sediment disposal options, the sediment no longer remains at the site; therefore, the acceptability of land use after the action is the same in each case.

Costs:

The costs presented below are developed in greater detail in Appendix A. The cost for offsite incineration of the sediment is included for the purposes of comparison. The offsite incineration cost includes the incineration fee (at SCA in Chicago, Illinois, or ENSCO in El Dorado, Arkansas since the costs are about the same), transportation costs, and ash disposal costs. Onsite incineration cost estimate includes mobilization and permitting of the incinerator, incineration fee, and ash disposal cost. For both offsite and onsite incineration, the ash is assumed to require disposal at an approved chemical waste landfill; substantial savings can be realized for both incineration options if the residual ash can be delisted and disposed of in a sanitary landfill or redisposed on site. The sediment stabilization and landfilling cost estimate includes the cost for equipment, materials, and labor to stabilize the sediment and the cost to haul the sediment to CECOS, Niagara Falls; the disposal costs listed below do not include removal of the sediment from the lagoon.

Method	Cost (Millions of Dollars)	
	40,000 yd^3	80,000 yd^3
Onsite Incineration	20.4	40.8
Offsite Incineration	86.0	172.0
Stabilization and Landfilling	17.2	34.3

From the above costs, it seems apparent that stabilization and landfilling is the least expensive option, followed closely by onsite incineration. However, it should be noted that the stabilization and landfilling cost estimate assumes that all of the sediment will be allowed to be stabilized and landfilled. If, on the other hand, some of the sediment contains greater than 500 ppm PCB, then that portion would require incineration. Because of space limitations at the site (as well as the cost to keep the onsite incinerator inactive) an onsite incinerator and a stabilization facility could not both be located on site at the same time. Therefore, if sediment stabilization and landfilling is the selected disposal option, then any sediment containing greater than 500 ppm PCB would need to be incinerated offsite. Under this scenario, if as little as 5 percent of the sediment contains in excess of 500 ppm PCB, (and must therefore be offsite incinerated), then the cost for stabilization and landfilling will increase to about the same cost as onsite incineration. As the percent of sediment containing greater than 500 ppm PCB is increased, the cost for the stabilization and landfilling option likewise increases. On the other hand, the onsite incineration cost remains constant, regardless of the PCB content of the sediment.

Recommendation for Sediment Disposal:

Onsite incineration is selected over offsite incineration at the very beginning of the evaluation because onsite incineration was preferred over offsite incineration for the oil disposal case, and sediment disposal is very similar to oil disposal.

Comparing onsite incineration to the option of stabilization and landfilling in terms of effectiveness, both options were roughly equivalent in terms of technology status, level of cleanup/isolation achievable, and acceptability of land use after the action. Stabilization and landfilling was slightly favored over onsite incineration in terms of risk and effect of failure, ability to meet legal and institutional requirements, and time to achieve cleanup, and was favored with respect to community impacts.

Onsite incineration, on the other hand, was slightly favored over stabilization and landfilling for its ability to meet public health and environmental criteria.

With respect to cost, stabilization and landfilling is less expensive than onsite or offsite incineration, assuming all of the sediment can be landfilled. However, if as little as 5 percent of the sediment contains greater than 500 ppm PCB, the cost for stabilization and landfilling plus the required offsite incineration would roughly equal the cost of onsite incineration. As the percentage of sediment containing more than 500 ppm PCB is increased, the cost for stabilization and landfilling quickly surpasses the cost for onsite incineration, and approaches the extremely expensive option of offsite incineration. Also, the cost for onsite incineration may be reduced if the residual ash from the incineration process can be delisted.

It is recommended that onsite incineration be used for the disposal of the lagoon sediment. Onsite incineration is effective for the sediment disposal and is potentially the least expensive option. Furthermore, since onsite incineration was recommended for the disposal of the oil, community relations problems would have already been addressed. Also, if a permit can be obtained for onsite incineration of the oil, it is reasonable to expect that it will be obtainable for the sediment disposal. A cost savings may also be realized if the permitting for the oil incineration and the sediment incineration is coordinated. Furthermore, onsite incineration can be used regardless of the PCB content of the sediment, and monitoring of the PCB content in the sediment would not be as vigorous as for the stabilization and landfilling options. Finally, if onsite incineration is used for the oil disposal, then it would be simpler and less costly to use the same incineration setup to handle the sediment than to demobilize the incinerator and construct the stabilization facility. Also, if the oil and sediment should become mixed, stabilization may no longer be possible (either technically or legally), while onsite incineration would still be applicable.

5.3.1.3 Waste Disposal--Water

Two options for the disposal of the BROS lagoon water passed the initial screening of alternatives. These water disposal options are:

- Onsite treatment
- Offsite treatment

General Description

Onsite Treatment:

The onsite treatment option for the disposal of the BROS lagoon water involves the construction of a treatment facility on site (similar to the EMPAK water treatment facility that is presently on site). The lagoon water would be pumped through this treatment facility and the treated water would be discharged to Little Timber Creek, assuming that adequate water quality can be achieved. Included in this option would be regular and frequent monitoring of the treatment plant effluent to monitor whether appropriate water quality criteria are being met. State and Federal discharge permits will be required.

Offsite Treatment:

This lagoon water disposal option involves pumping the lagoon water into tanker trucks and hauling it to a nearby industrial wastewater treatment facility. In the scoping of this option, the Dupont Chambers Works was assumed to be the treatment facility that would be used for disposal of the water. The Dupont Chamber Works is located less than 20 miles from the BROS Site. This disposal option assumes that the lagoon water is acceptable for treatment at Dupont.

Evaluation of Alternatives

Technology Status:

The technology status of the two water disposal options is roughly equivalent even though different unit processes may be used in either case (i.e., powdered activated carbon treatment at Dupont versus granular activated carbon adsorption for onsite treatment). The Dupont facility is currently operating on an industrial scale so the technology status is documented and accepted. The onsite treatment facility that is currently at the BROS Site is providing adequate treatment of the lagoon water; thus the technology status of onsite treatment is also demonstrated to be good.

Risk and Effect of Failure:

With respect to risk and effect of failure, offsite treatment would be favored over onsite treatment. The risk associated with offsite treatment is minimal compared to onsite treatment since the lagoon water would be taken to a plant with the capacity to treat millions of gallons per day and the BROS water would constitute a small fraction of the total treatment stream. Onsite treatment would have a degree of risk greater than offsite treatment. Since the onsite treatment facility would be very small in comparison to offsite treatment, a small problem could result in inadequate water treatment. The effect of such a failure would be that contaminated water would be discharged to Little Timber Creek. One risk that would be associated with the offsite treatment option is the potential for a spill during hauling; however, assuming that proper hauling practices are employed and assuming that the offsite treatment facility is nearby, the risk of such a spill would be reduced.

Level of Cleanup/Isolation Achievable:

The level of cleanup achievable with each of the water disposal options is roughly equal, assuming proper design and operation of the onsite facility and assuming that the water is acceptable to the offsite treatment plant.

Ability to Minimize Community Impact:

Community impacts under each of these options is about equal. Residents may be skeptical about the adequacy of an onsite unit; however, the existing facility at the site has apparently been well received by the local populace. Offsite treatment requires that tanker trucks enter and leave the site, but the effect of increased truck traffic in the area should not disrupt the local residents, with the possible exception of the few residents in the immediate vicinity of the site, since a major highway is easily accessed from the site.

Ability to Meet Relevant Public Health and Environmental Criteria:

Assuming proper design and operation of the onsite facility, and acceptability of the water at an offsite facility, each of the lagoon water treatment options should be equally capable of meeting relevant public health and environmental criteria.

Ability to Meet Legal and Institutional Requirements:

Offsite treatment of the water is slightly favored over onsite treatment of the water with respect to legal and institutional requirements since the offsite facility is presumably fully permitted and licensed. Onsite treatment would require securing applicable State and Federal permits; however, since the existing water treatment facility at the site has been permitted, it is assumed that permitting of onsite treatment at a later date should be possible.

Time Required to Achieve Cleanup/Isolation:

In general, the onsite treatment facility would be limited by its capacity flow rate, and offsite treatment would be limited by how quickly hauling vehicles could be brought to the site and how quickly they could be loaded. Nevertheless, it is expected that water treatment will be required throughout the cleanup activities, so, in this respect, both disposal options would be about equal in the length of time required to achieve cleanup.

Acceptability of Land Use After Action:

This evaluation criterion is not applicable to the water treatment options.

Costs:

Because of the uncertainty regarding the quantity of water that may require treatment, the costs were developed for the estimated least and greatest quantity of water that is expected to need treatment. The onsite treatment cost estimate includes the capital cost for the treatment plant and the operation costs for the system (labor, chemicals, energy, sludge disposal). The capital cost and operation costs for onsite water treatment are based on a system that is similar to EMPAK's treatment facility that is currently at the site. The offsite treatment cost estimate includes labor (to load the hauling vehicle), transportation costs, and the disposal fee at the Dupont Chambers Works.

Alternative	Cost (Millions of Dollars)	
	4.4×10^7gal	9.5×10^7gal.
Onsite treatment	4.08	7.76
Offsite treatment	7.21	15.4

From the cost estimates shown, it is apparent that onsite water treatment is about one-half the cost of offsite water treatment (at the Dupont Chambers Works).

Recommendation for Lagoon Water Disposal:

From the previous discussion, onsite treatment of the lagoon water is about equal with offsite treatment in terms of technology status, level of cleanup achievable, community impacts, ability to meet public health and environmental criteria, and the time required to achieve cleanup. Offsite treatment is slightly favored with respect to risk and effect of failure and ability to meet legal and institutional requirements. In terms of costs, onsite treatment costs about half as much as offsite treatment at the Dupont Chambers Works.

It is recommended that onsite water treatment be used for the treatment of contaminated water in the lagoon. The system that is currently at the site is apparently providing adequate treatment, so onsite treatment is proven to be effective, and onsite treatment is estimated to cost about half as much as offsite treatment.

5.3.1.4 Lagoon Cleanout

From the discussion presented in Section 4 of this report, it is evident that removal of the contaminated lagoon oil, water, and sediment is the only alternative available, since all options that left these wastes in place were screened from further consideration. The actual method of lagoon cleanout will need to be studied in the conceptual design, although site conditions that may become evident during the cleanout operation, as well as the preferences of cleanout contractors, may, substantially modify any waste removal method that is conceptually developed. This subsection presents a discussion of possible removal techniques, highlighting areas of particular concern.

Water Removal

Pumping the water out of the BROS lagoon is a straightforward and well established technology and would be the method used to remove the lagoon water. The real problem concerning water removal does not involve the method of removal, but instead involves the time of removal. The following points illustrate this problem:

- EMPAK, Inc., currently has a water treatment facility on the site, and they are removing and treating lagoon water under contract with the Army Corps of Engineers. The cost for water removal and treatment is a very reasonable 2 cents per gallon, contingent upon EMPAK's being able to remove and treat 35 million gallons (plus or minus 15 percent). EMPAK should be able to fulfill this contract sometime in 1984. Once the contract is fulfilled, EMPAK will presumably remove the treatment facility from the site and look for work elsewhere.

- Rainfall continues to collect in the lagoon for reasons stated earlier. The rate of rainfall accumulation may be as high as 8 million gallons per year. If it takes 2 years before cleanup work at the site is initiated, an additional 16 million gallons of rainwater may have accumulated in the lagoon. Additionally, rainfall may accumulate in the lagoon during site cleanup, which may take another 2 years or more.

- Because of the large amount of rainfall that is expected to accumulate in the lagoon once EMPAK leaves the site, some other form of water treatment will be needed (either an onsite treatment facility or the hauling of water to an offsite industrial wastewater facility). Regardless of the form of water disposal used after EMPAK leaves, it is unlikely that EMPAK's treatment cost can be equaled because of a unique, one-time-only contractual agreement between EMPAK and the Army Corps of Engineers. In fact, subsequent treatment costs may be three to six times as expensive as EMPAK's cost.

- The oil phase of the lagoon is far easier and less expensive to remove if it is floating on top of the water than if it is mixed with the sediment.

- The cost to dispose of the oil and sediment does not change whether these tasks are done separately or together, assuming that the oil and the sediment will be incinerated onsite. If, however, some form of disposal other than onsite incineration is ulitimately selected, then the overall cost to dispose of the oil and sediment may be highly dependent on whether these two wastes are separated or mixed.

- As the lagoon level is lowered by water removal, the floating oil layer will come into contact with the sediment. It is uncertain whether the oil will separate from the sediment after it has made contact and subsequent rainfall accumulation causes the lagoon level to rise again.

From this discussion, it is evident that the method of oil removal will depend on how much water is removed by EMPAK, whether the oil contacts the sediment, and whether the oil will separate from the sediment after it has made contact. Removing the oil by pumping while it is floating on the water is less expensive than dredging it along with the sediment, as illustrated by the following costs:

Method	Cost (Millions of Dollars)	
	2×10^6 gal	3×10^6 gal
Oil Removal - Pumping	0.35	0.44
Oil Removal - Dredging	0.61	0.92

The oil dredging costs do not include the cost for dredging equipment since it is assumed that the dredging equipment would be needed to remove the sediment in any case. The oil pumping cost does include the necessary equipment because this equipment is specific to oil removal by pumping.

Because of an unusual contractual agreement, EMPAK can treat the lagoon water less expensively than any subsequent water treatment method. Therefore, the overall water disposal cost will decrease as the amount of water treated by EMPAK increases. Assuming a cost differential of 6 cents per gallon (water treatment now by EMPAK versus water treatment at the time of cleanup), the amount of water that EMPAK would need to treat in order to overcome the cost differential between dredging the oil and pumping the oil can be calculated. The oil removal cost difference (2×10^6 gal case) for pumping versus dredging is about \$260,000. EMPAK would need to treat 4.3 million gallons in order to make up the cost differential of lowering the oil to the point where it would need to be dredged rather than pumped. From analysis of the lagoon contours developed from lagoon sounding data, the water volume in the lagoon at the point where the oil begins to intimately contact the sediment (elevation 2 feet MSL) would be substantially less than 4 million gallons. Therefore, no overall savings will be realized by lowering the lagoon beyond the point where the oil just contacts the sediment, since the savings in water treatment will not offset the additional cost of dredging the oil. Based on this discussion, it is recommended that EMPAK remove and treat lagoon water down to the point just before the oil contacts the sediment. This point is estimated to be at approximately elevation 3 feet MSL for the oil/water interface, or, assuming 2 million gallons of oil, at an oil level of about elevation 4.5 feet MSL. If the lagoon level is lowered to this point, then the oil should not contact the sediment, at least not intimately, and the volume of water removed by EMPAK can be maximized without causing oil removal problems at the time of cleanup.

5.3.1.5 Lagoon Closure

Two options have been identified for the final closure of the BROS lagoon. These options are:

- Backfilling and revegetation

- Revegetation and leaving the lagoon as a pond

General Description

Backfilling and revegetation:

Under this alternative (hereafter referred to as the backfilling option) the lagoon would be backfilled to above the high water table elevation and then revegetated. The contours of the backfilled lagoon would be such that rainwater runoff would discharge into the Little Timber Creek Swamp and would not collect in the lagoon area. Also, a security fence with signs explaining the hazardous nature of the closure area would be installed to warn against and reduce the possibility of unauthorized entry. Consideration was given to installing an impermeable cap over the lagoon area; however, this consideration was eliminated for two reasons: (1) all or nearly all of the contaminated soil and sediment in the lagoon area will be removed and (2) any remaining contaminated material would most likely be below the water and in direct contact with the groundwater. Therefore, an impermeable cap would not reduce the possibility of groundwater contamination from this source since impermeable caps are designed to reduce groundwater contamination resulting from the leaching of wastes (located above the water table) by rainwater infiltration.

Revegetation and leaving the lagoon as a pond:

Under this option (hereafter referred to as the pond option) the lagoon would not be backfilled. Instead, the lagoon sides would be contoured and revegetated, and the cleaned lagoon would remain as a pond. Also, a security fence with signs explaining the hazardous nature of the closure area would be installed around the site to reduce the potential for unauthorized entry. Since the semi-impermeable, oily sediment/sludge layer of the lagoon would be removed, the lagoon level would be able to fluctuate with the water table and the lagoon level would not continue to rise as it does now. With this option, the lagoon would be expected to behave in much the same manner as the adjacent Gaventa and Swindell Ponds.

Evaluation of Alternatives:

Technology Status:

The technology status of each of the lagoon closure options is well-established and commonly used.

Risk and Effect of Failure:

The risk of failure of either of these options is very low. Failure would be identified as the lagoon's not communicating with the groundwater and instead accumulating water. The risk of this occurring is the same in either case since this failure would be associated with the sediment cleanout and not the closure. The effect of failure in either case would also be the same. For the backfilling option, the lagoon level would rise from rainwater infiltration through the cover until it reached the level at which it would flow into Little Timber Creek. For the pond option, the lagoon level would rise from rainwater accumulation until the pond overflowed into Little Timber Creek. In either case, it should be noted that the water level would not rise as quickly as it does now because of increased permeability of the sediment and removal of the floating oil layer that prevented evaporation.

Level of Cleanup/Isolation Achievable:

The backfilling option would achieve a higher degree of isolation than the pond option because if any contaminated material remained in the lagoon, the backfill would effectively prevent human contact with it (although environmental contact would not be reduced). For the pond option, however, if any contaminated material remained at the base of the lagoon, human contact with the waste could occur if someone were to trespass into the lagoon area and go swimming.

Another potential contact problem that exists for the pond option would be bioaccumulation of PCBs in the food chain. If not all of the PCB-contaminated waste is removed from the lagoon, then it is possible that plant life growing within the pond would accumulate PCBs. These plants could then become a source of PCB in waterfowl that land at the site. Sportsmen who hunt these waterfowl could potentially become exposed to PCBs through ingestion.

Ability to Minimize Community Impacts:

Neither closure alternative would adversely affect the local community. However, local residents may perceive the backfilling option as being safer than the pond option, since the image of a pond in the lagoon area may make them feel that the problem is still at the site. Also, leaving the lagoon as a pond may be an invitation for unauthorized entry to take place, although the fence and warning signs should reduce the potential for that occurrence. The pond option could be made more favorable by planting coniferous trees around the site to prevent people in the local community from seeing the closed lagoon.

Ability to Meet Relevant Public Health and Environmental Criteria:

The lagoon closure options are equivalent in their ability to meet public health and environmental criteria.

Ability to Meet Legal and Institutional Requirements:

The lagoon closure options are roughly equal in their ability to meet legal and institutional requirements.

Time Required to Achieve Cleanup/Isolation:

The time to complete the pond option would be less than the backfilling option because the backfilling option requires that more than 100,000 cubic yards of backfill material be brought to the site. Nevertheless, either closure alternative should be able to be completed in less than one construction season.

Acceptability of Land Use After Action:

The lagoon closure options are equivalent in this respect because access to the site would be restricted in either case.

Costs:

The costs for the two lagoon closure options are presented below. For the backfilling option, the cost estimate includes backfilling with rock to the water table (for stability), followed by gravel, banksand, and common borrow to achieve the desired contours. This cost also includes a topsoil cover and revegetation. The pond option cost estimate includes only topsoil and revegetation. Both cost estimates include all necessary labor. The cost for fence installation is not included since a fence already exists at the site.

Option	Cost (Millions of Dollars)		
	40,000 yd^3	80,000 yd^3	30-year O&M Present Worth
Backfilling and revegetation	2.39	3.80	0.222
Revegetation and leaving the lagoon as pond	0.211	0.211	0.272

Recommendation for Lagoon Closure:

From the previous evaluation, it was determined that the backfill option and the pond option are about equal in terms of technology status, risk and effect of failure, ability to meet health and environmental criteria, and ability to meet legal and institutional requirements. The backfilling option was slightly favored in terms of community impacts and more heavily favored in terms of the level of isolation achievable. The pond option was slightly favored with respect to the time to implement.

In terms of cost, the pond option is substantially cheaper than the backfilling option, being an order of magnitude less expensive.

Based on the low risk associated with both of these closure options and based on the substantial cost difference, it is recommended that the cleaned lagoon be closed by revegetating its sides and allowing it to remain as a pond.

5.3.2 Tank Farm

Only two alternatives pertaining to the tanks and tank wastes at the BROS Site passed the initial screening phase. These alternatives are:

- Removal of tank wastes and cleaning of tanks
- Complete removal of tanks and waste

It is obvious that in all cases concerning effectiveness, complete removal of the tanks and waste is equal or superior to the option of removing the waste and leaving the cleaned tanks on site. With complete removal of the tanks and waste there would be no chance for rainwater to accumulate in the tanks, there would be no possibility of unauthorized access into the tanks, and there would be no incentive for unauthorized disposal of wastes in the tanks. Community impacts would be more favorable for the complete removal option as compared to leaving the cleaned tanks on site, because tanks would no longer be present at the site and local citizens would see a definite improvement at the site. Also, the level of cleanup would be greater for the complete removal option, even though the time to achieve cleanup would be about the same for both options. Most importantly, complete removal of the tanks and waste would greatly increase the available working space at the site. This additional work space is essential if the lagoon cleanup activities are to occur.

Costs:

The costs presented below include removal, transportation, and disposal of the waste, and cleaning of the tanks. The cost for the option of complete removal includes demolition, removal, transportation, and disposal of the tanks.

Alternative	Cost (Millions of Dollars)
Removal of tank waste and cleaning of tanks	1.18
Complete removal of tanks and waste	1.61

From the above cost estimates, it is apparent that complete removal of the tanks and waste is only slightly more expensive than leaving the cleaned tanks on site, especially as compared to the costs for other site actions such as sediment removal and disposal.

Recommendation for the Tank Farm:

It is recommended that the tanks and tank waste be completely removed from the site. This recommendation is based on several factors. First, and foremost, is the fact that the recommended lagoon action presented in Section 5.3.1 requires that the tanks be removed from the site so that there is sufficient room to set up the onsite incinerator and lagoon waste removal equipment. Second, complete removal of the tanks is equal to or superior to the option of leaving the cleaned tanks on site for all effectiveness considerations. Finally, the incremental cost to demolish and remove the tanks rather than leaving them on site is not significant when compared with the cost for other actions at the site.

5.3.3 Residential Wells

From the initial screening of alternatives, all three residential well options were retained for further consideration. These options are:

- No action/monitoring
- Carbon filtration of each well
- Pipeline extension from the Pennsgrove water system

It should be noted that even if all of the contaminated material is removed from the site and further groundwater contamination is stopped, action is still warranted for the residential wells because the contamination that is currently in the groundwater will continue to threaten these wells.

General Description

As discussed in the groundwater section of this report (Section 3.2.2), only ten residential wells will be considered for remedial action at the BROS Site. These wells are: Keller (Van Scoy), Pepper Industries, Fish Diesel Repair (Smith's Garage), Byrnes, Lindle, Cahill, Newton, Fryberger, Hillman, and Bell. The reasons for choosing these wells were outlined in Section 3.2.2.

No Action/Monitoring:

The no action/monitoring option (hereafter referred to as "no action") involves only performing periodic sampling of the residential wells. In the scoping of this option, it was assumed that all ten wells would be sampled quarterly for volatile organics and annually for the full HSL. Also included would be the sampling of six monitoring wells in order to determine if a plume "wave front" was approching the residential wells. Since the Keller well already has a carbon filtration unit, the no-action option would allow for the carbon filter to be changed annually. A disadvantage of this option is that it only monitors contamination but does nothing to reduce or eliminate the contamination. Therefore, if unacceptable levels of contaminants are detected in the water, some other action would still need to be taken.

Carbon Filtration of Each Residential Well:

This option (hereafter referred to as the carbon filter option) involves installing a granular activated carbon filter on each individual well. The carbon filter acts to purify the well water by adsorbing chemical contaminants. Also included in the carbon option would be the same monitoring program as for no action, with the exception that two samples would be collected from each residential well (i.e., before and after the carbon filter). The carbon option is scoped to also involve annual changing of the carbon in each carbon filter.

Alternate Water Supply - Pipeline from Pennsgrove Water Supply Company:

This option (hereafter called the "pipeline" option) involves the installation of a potable water pipeline from the Pennsgrove water system to the affected residents. The pipeline is not scoped to include fire protection. This option assumes that the Pennsgrove Water Supply Company will pay for and complete the system improvements that were outlined in an Administrative Order from the New Jersey Division of Water Resources on December 8, 1981. These improvements include the construction of a new, duplicate supply well and the replacement of undersized mains. According to the Order, these actions must be completed before any extensions to the existing system will be permitted. The pipeline option would not require any ongoing residential well monitoring and would effectively isolate the residents from the contaminated groundwater. Sealing of the residential wells would also be considered under this action.

Evaluation of Alternatives

Technology Status:

The technology status of each of the three well options is well established and commonly used. Therefore, in terms of technology status, each of the well options is roughly equivalent.

Risk and Effect of Failure:

In terms of risk and effect of failure, the pipeline alternative would show the least risk. The carbon option would be ranked second, since there is a considerble risk that contaminants could break through the carbon filter, especially if contaminant levels would quickly and unexpectedly increase. The effect of a failure with respect to the carbon option would be the possibility of residents drinking contaminated water until the results from the next sampling round indicated the breakthrough. The no-action option would present the greatest risk, and a failure would result in the drinking of contaminated water by the residents. Also, if unacceptable levels of contamination are detected in the residential wells, the no-action alternative would be useless and some other action would need to be taken. For the carbon option, however, the carbon changing rate could be accelerated if breakthroughs are observed.

Level of Cleanup/Isolation Achievable:

Once again, the pipeline option is rated the highest with respect to the other two residential well options because the pipeline would effectively isolate the residents from the contaminated groundwater. Carbon filtration would rank second because although the groundwater would still be used, the carbon filter would remove some or all of the contaminant and thereby partially isolate the residents from the contaminated groundwater. The no-action option rates the lowest since no cleanup or isolation is achieved under this option.

Ability to Minimize Community Impacts:

It is obvious that the pipeline option would be, by far, the most favored by local residents. Furthermore, installation of the pipeline would not significantly disrupt the everyday life of the community. Carbon filters would be viewed less favorably, since many residents may be skeptical of their effectiveness; nevertheless, carbon filters would be favored over the no-action option. Also, under the carbon filter and no-action options, residents may be disrupted slightly by the need for periodic water monitoring and carbon changing.

Ability to Meet Relevant Public Health and Environmental Criteria:

The pipeline option would best meet public health criteria since it is assumed that the municipal water system distributes water of satisfactory quality. The carbon filter option would be second best since the possibility exists that contaminants could break through the carbon and cause the domestic water quality to temporarily exceed drinking water standards. This situation could be rectified by changing the carbon more frequently. The no-action alternative would do nothing to meet public health criteria, except to indicate when water quality standards are being violated.

Ability to Meet Legal and Institutional Requirements:

No legal or institutional requirements have been identified for the no-action or carbon options. Permits to install the pipeline may be required; however, these permits should not be difficult to secure, assuming that the aforementioned system improvements are made.

Time Required to Implement the Action:

The no-action and carbon options could be implemented immediately. The pipeline option, on the other hand, would take from 1 to 3 months to actually install, assuming that the necessary system improvements are made. Since no system extensions are allowed until these improvements are completed, the pipeline option may be delayed for some time.

Acceptability of Land Use After Action:

This effectiveness measure is not applicable to the residential well options.

Costs:

The costs presented below are broken down into capital costs and annual operation and maintenance (O&M) costs. The O&M costs are also converted to a 30-year present worth (assuming 10 percent interest and 0 percent inflation). The pipeline capital cost includes materials and labor to install a 6-inch-diameter pipeline for a length of 8,000 feet, including ten home connectors, excavation, backfill, meter boxes, and repaving. The cost for the Pennsgrove system improvements, outlined in the New Jersey Division of Water Resources Administrative Order, are not included because these improvements are assumed to be performed and funded by the Pennsgrove Water Supply Company. Pipeline O&M costs include the cost for water service and the base annual service charge. Carbon filter capital costs include material and labor to install the carbon filter. The carbon filter option annual O&M cost includes labor and analytical costs for the monitoring program outlined in the option description, and labor and materials for annually changing the carbon. The no-action option has no capital costs; the O&M costs include labor and analytical costs for monitoring. All work is assumed to be performed by local workers.

Alternative	Cost (Millions of Dollars) Capital	Annual O&M	30 year O&M present worth
No Action	0	0.048	0.454
Carbon filtration	0.020	0.071	0.672
Water pipeline	0.294	0.002	0.023

From the above costs it is obvious that the pipeline option has the highest capital cost by far. However, when the capital cost and the 30-year O&M present-worth costs are added, the pipeline option is the least expensive followed by no action and the carbon filter option.

Recommendation for Residential Wells:

From the previous evaluation of the residential well alternatives, it is evident that providing a potable water pipeline to the affected residents is the most effective option. The pipeline option was favored over the carbon filter and no-action alternatives in terms of risk and effect of failure, level of isolation achievable, community impacts, and ability to meet public health criteria.

With respect to costs, the pipeline option has by far the largest capital cost; however, when the costs for long-term maintenance and monitoring are included, the pipeline option is the least expensive. Furthermore, the pipeline option solves the problem of contaminated domestic wells, whereas the no-action option only monitors the problem. If substantially more contamination begins to appear in the residential wells then the no-action option will only be able to alert the people to the fact that some other action is needed, and the carbon filter option may become ineffective; on the other hand, regardless of the contaminant levels in the domestic wells, the pipeline option would continue to provide potable water to the residents.

It is recommended, based on the previous evaluation, that a potable-water pipeline be installed so as to provide the affected residents in the vicinity of the BROS Site with a suitable water supply. The Pennsgrove Water Supply Company is the likely source of water for this pipeline since it is located near the affected residents; however, the Pennsgrove system improvements that were outlined by the New Jersey Division of Water Resources must be implemented before additional connections to the system can be made. It is also recommended that the pipeline be installed and operating before the lagoon sediment is disturbed, because it is possible that lagoon sediment dredging will cause a wave of increased groundwater contamination and migration to occur.

5.4 Summary of Alternatives, Evaluations, and Recommendations

From the evaluations presented in Sections 5.1 through 5.3, an overall remedial action for the BROS Site has been recommended. This recommended overall action is the combination of the recommended actions from each of the categories pertaining to some aspect of the site remediation. The various remediation categories, along with the recommended option for each category, are presented below:

- Lagoon Waste Removal
  - Pump out oil, pump out water, dredge sediment (assuming that EMPAK, under its present contract with the Army Corps of Engineers, will not lower the lagoon level to the point where the sediment and oil become mixed).

- Lagoon Waste Disposal - Oil
  - Onsite incineration.

- Lagoon Waste Disposal - Sediment
  - Onsite incineration.

- Lagoon Waste Disposal - Water
  - Onsite treatment.

- Lagoon Closure
  - Revegetation and leaving the cleaned lagoon as a pond.

- Tank Farm
  - Complete removal of the tanks and waste.

- Residential Wells
  - Provide a water supply pipeline from Pennsgrove Water Supply Company (assuming that Pennsgrove makes the system improvements outlined by the New Jersey Division of Water Resources).

The estimated costs associated with this overall action are presented in Table 5-1. The method of performing the onsite and offsite work for this recommended overall action will be further detailed in the conceptual design.

With regard to the quantity of lagoon sediment to be removed and disposed of, cost estimates were developed based on 2 feet of sediment excavation and 4 feet of sediment excavation. These estimates are only engineering guesses because the variation in sediment contamination with respect to excavated depth is unknown. Therefore, it is recommended that a comprehensive sampling and characterization of the lagoon sediment be performed before excavation activities begin. This characterization should attempt to determine sediment contamination versus depth so that the appropriate amount of sediment can be removed. If possible, this sampling should be performed as near as possible to the time of cleanup, since the sampling is expected to involve the placement of numerous borings into the bottom of the lagoon. These borings may act as "drains" which could allow the liquid contents of the lagoon to flow more freely into the local groundwater.

TABLE 5-1

COST ESTIMATES FOR THE RECOMMENDED
OVERALL REMEDIAL ACTION
BRIDGEPORT RENTAL AND OIL SERVICES SITE

Action	Capital Cost[1] (Millions of Dollars) Low	Mean	High	30 Year O & M Present Worth (Millions of Dollars)
Lagoon				
• Oil removal	0.35	0.40	0.44	--
• Sediment removal	4.45	6.50	8.56	--
• Onsite incineration of oil	1.93	2.42	2.90	--
• Onsite incineration of sediment	20.4	30.6	40.8	--
• Onsite treatment of water	4.08	5.92	7.76	--
• Lagoon closure		0.21		0.272
Tank Farm				
• Complete removal of tanks and waste		1.61		--
Residential Wells				
• Water supply pipeline from Pennsgrove Water Company		0.29		0.023
Total Cost Estimate for Recommended Actions		48.0		**0.295**

1 Because of the uncertainty regarding the amount of waste present in the lagoon, a range of costs has been provided for waste removal and disposal actions.

APPENDIX A

TREATABILITY STUDY OF DISPOSAL ALTERNATIVES FOR LAGOON OIL AND LAGOON SEDIMENT

A.1 Introduction

In conjunction with the Feasibility Study that was performed for the BROS Site, a Treatability Study was conducted to evaluate disposal alternatives for the BROS lagoon oil and sediment.

Analyses conducted during the Remedial Investigation showed that PCB concentrations ranged from less than 100 to 1,380 parts per million (ppm) in the lagoon oil and from 190 to 1,400 ppm in the lagoon sediment. Table A-1 presents a summary of the observed PCB levels in the oil and sediment, as well as the oil and grease concentrations observed in the sediment. As Table A-1 illustrates, the PCB concentrations are spread over a wide range, varying by as much as an order of magnitude. Nevertheless, the average PCB concentration in each phase exceeded 500 ppm. It is interesting to note that the PCB concentration in the sediment does not necessarily follow the oil and grease concentration. The highest observed PCB level did occur in the sample with the highest oil and grease; however, the sample with the lowest oil and grease showed the second-highest PCB concentration.

Relative to the aforementioned PCB analytical results, the concentrations of other contaminants in the oil and sediment are only of minor significance in terms of disposal alternatives. The observed levels of PCBs will be the most critical factor in determining the method of oil and sediment disposal; therefore, this treatability study focuses on disposal of the oil and sediment as PCB-contaminated material.

A.2 Disposal Options

For materials contaminated with greater than 500 ppm PCB, the disposal options are limited. Available information indicates that the acceptable disposal options are: thermal destruction at an incinerator licensed to handle PCB; and landfilling

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TABLE A-1

SUMMARY OF PCB CONCENTRATIONS OBSERVED
IN LAGOON OIL AND SEDIMENT DURING REMEDIAL INVESTIGATION
BRIDGEPORT RENTAL AND OIL SERVICES SITE

Sample Identification	Sample Type	Total PCB (µg/kg)	Oil & Grease (percent)
LS-03-01	Sediment	1,400	61
LS-03-02	Sediment	450	32
LS-03-03	Sediment	210	50
LS-03-04	Sediment	190	43
LS-03-05	Sediment	600	14
	Average	570	40
LS-01-01	Oil	1,380	--
LS-01-02	Oil	600	--
LS-02-03	Oil	< 100	--
LS-01-04	Oil	200	--
LS-01-05	Oil	1,055	--
	Average	667	

Source: NUS Laboratory Services Division, Pittsburgh, Pennsylvania, August 22,1983 at an approved chemical waste landfill (nonliquid, nonignitable PCB-wastes only). A number of other potential disposal/destruction methods are available, including dechlorination and microbial degradation.

Dechlorination processes (e.g. Acurex, KOHPEG, NaPEG, PCBX, and Goodyear) were eliminated from consideration as disposal methods for the following reasons:

- Many dechlorination processes are still in the testing phase and have not received EPA approval for commercial-scale use.

- Those processes that are EPA-approved are not suitable to the oil and sediment at the BROS Site, since many of these processes were specifically designed to treat transformer oil and other "clean" fluids.

Microbial degradation was eliminated as a possible PCB destruction technique based on current research which indicates that no specific microorganism has been discovered that will oxidize or degrade highly chlorinated biphenyls (communication with Albert Klee, EPA Research Labs, Cincinnati, Ohio, March 1984). Similarly, a site-specific study conducted by Camp Dresser and McKee (CDM) in August 1982 concluded that biological treatment was unsuitable for treatment of the lagoon waste. Reasons cited by CDM included observed slow rates of biooxidation and the lack of evidence regarding any bacterial acclimation. This study by CDM concentrated on the treatment of the lagoon water; consequently, treatment of the oil and sediment by biological means can be considered even less feasible.

With respect to the hazardous waste landfilling of materials containing greater than 500 ppm PCB, current EPA policy seems to prohibit this alternative, especially if the PCB material is liquid or contains free liquids. The Toxic Substances Control Act (TSCA), final PCB Rule (40 CFR 761), states that any liquid material containing greater than 500 ppm PCB must be disposed of in an approved high-temperature incinerator. The Rule goes on to say that dredged materials and municipal sewage treatment sludges containing PCB shall be disposed of in either a high-temperature incinerator or in an approved chemical waste landfill. The approved landfill must ensure that liquid materials containing more than 500 ppm PCB are not disposed in the landfill. Furthermore, processing liquid PCB-materials into nonliquid PCB-materials is only permitted for liquids containing less than 500 ppm PCB. Based on this PCB rule, it seems apparent that the lagoon oil must be incinerated. Since the lagoon sediment is expected to contain a substantial quantity of liquid, especially in light of its saturated condition at the bottom of the lagoon and its high oil and grease content, sediment disposal may also be limited to incineration, unless some satisfactory method of dewatering can be implemented or approval to solidify the sediment is received.

There is, however, one contingency that is available under the PCB Rule for materials containing more than 500 ppm PCB. An alternate method of PCB material disposal can be implemented if specifically approved by the EPA Regional Administrator. In general, for such an approval to be received, it must be demonstrated that disposal by the methods and rules outlined in 40 CFR 760 is unreasonable or inappropriate. Although such a regional approval is considered to be unlikely, there is a possibility that one or more of the following disposal alternatives could be allowed:

- Stabilization of lagoon sediment with subsequent disposal at a chemical waste landfill.

- Stabilization of a mixture of lagoon oil and sediment with subsequent disposal at a chemical waste landfill.

- Stabilization/Fixation of lagoon sediment with in-situ disposal.[1]

- Stabilization/Fixation of a mixture of lagoon oil and sediment with insitu disposal.[1]

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[1] These alternatives are likely to meet substantial resistance from the State of New Jersey.

A.3 Incineration

Since incineration seems to be the most likely method of lagoon oil and sediment disposal, this method was given the most consideration in this Treatability Study. The following subsections present information concerning those identified high-temperature incinerators that may be capable of disposing of the lagoon oil and/or sediment.

- At-Sea-Incineration, Inc. (ASI)

  ASI plans to incinerate organic liquids, including PCB-contaminated liquids, aboard specially designed ocean-going incinerator vessels. Although ASI is currently in the process of securing the necessary permits to become fully operational, one or two test burns (1.3 million gallons each) are planned for 1984-1985. ASI uses liquid injection incinerators on its vessels. This type of incinerator can only incinerate liquids and has a low tolerance for suspended solids. ASI is currently using Philadelphia, Pennsylvania, as its terminal facility, although a permanent terminal facility in the Newark, New Jersey, area is planned for the future.

- Chemical Waste Management, Inc. (CWM)

  CWM plans to incinerate organic liquids, including PCB contaminated liquids, aboard specially designed incineration vessels similar to those owned by ASI. CWM does not have the necessary permits in place at the time of this writing (April 1984) to incinerate wastes generated in the United States, although CWM has been incinerating organic liquids generated abroad. CWM is expecting to have the necessary permits to incinerate U. S. wastes within the next year or so. The CWM vessel uses liquid injection incinerators, which can only handle liquids and which have a low tolerance for suspended solids. Once the necessary permits are secured, CWM is expected to use some port on the Gulf Coast as its terminal facility.

- Energy Systems Company (ENSCO)

ENSCO has two PCB-contaminated waste disposal options. The first is its permanent incineration facility, located in El Dorado, Arkansas. This facility is licensed to handle PCB-materials, and, since it is a rotary kiln incinerator, can incinerate liquid and nonliquid materials.

The second option available from ENSCO comes from its subsidiary, Pyrotech System, Inc. Pyrotech owns and operates mobile rotary kiln incinerators that are licensed to incinerate PCB materials. These mobile incinerators are truck-mounted and include on-board laboratory facilities for all necessary analyses. Since these mobile units use rotary kiln incinerators, they are capable of incinerating liquid and nonliquid materials.

- Rollins Environmental Services, Inc. (Rollins)

Rollins presently owns and operates a rotary kiln incinerator at its facility in Deer Park, Texas. This facility is licensed to incinerate PCB waste, and, since it is a rotary kiln incinerator, can handle liquid and nonliquid materials. Rollins also owns and operates an incinerator facility in Bridgeport, New Jersey, located less than 10 miles from the BROS Site. Although the Rollins Bridgeport incinerator is reported to be exactly the same as the Deer Park facility, the Bridgeport incinerator has not yet been licensed to incinerate wastes containing greater than 50 ppm PCB. Rollins is attempting to license the Bridgeport incinerator for PCB materials, but it is unknown whether and when such licensing will be granted.

- SCA Services (SCA)

SCA has recently obtained the necessary permits to incinerate PCB materials at their facility located near Chicago, Illinois. This incinerator is a rotary kiln type and can; therefore, handle liquid and nonliquid wastes.

- General Electric (GE)

  GE operates a PCB waste incinerator in Pittsfield, Massachusetts. This incinerator is of the liquid injection type and was specifically designed for the incineration of transformer oils and similar liquids with high concentrations of PCBs. The GE incinerator can only handle liquids and has a very low tolerance for suspended solids.

In addition to the above-mentioned commercial incinerators, the EPA operates a mobile, rotary kiln incinerator. The EPA incinerator has received its TSCA permit for the incineration of liquids containing up to 40 percent PCB and is in the process of securing a permit to incinerate PCB solids as well. However, the EPA mobile incinerator is presently used for small cleanup jobs and may not be available for a long-term commitment, as would be necessary for the BROS Site.

A.4 Treatability Analyses

In order to determine whether any of the previously mentioned incinerator facilities were capable of disposing of the lagoon liquid and/or sediment, and in order to develop reliable disposal cost estimates, samples of the oil and sediment were sent to each of the commercial incinerator facilities mentioned (with the exception of the GE facility, which was determined to be unsuitable because of the high solids content of the BROS lagoon oil and sediment). In addition, samples were sent to CECOS International for evaluation of landfilling (CWM also evaluated the landfill option), and to Velsicol Chemical Corporation for stabilization/fixation analysis.

The samples that were used for the Treatability Study were collected from the BROS lagoon on January 11, 1984, by personnel from EMPAK, Inc., with oversight provided by NUS personnel.

Of the samples that were sent to prospective disposers, the following laboratories provided analytical support: RECRA Research, Inc. (associated with CECOS International); ENTEK Laboratories (associated with ENSCO); and an unknown laboratory subcontracted by At-Sea-Incineration, Inc. In addition, samples of the oil and sediment were sent to the NUS laboratory for analysis of the so-called "incineration parameters." The results of these analyses are summarized in Tables A-2 and A-3. Table A-2 presents the results for the lagoon oil; Table A-3 presents the results for the lagoon sediment.

An important point that should be noted concerns the PCB analyses of the oil and sediment from the Treatability Study. The PCB content of the lagoon oil appears somewhat consistent with the NUS Remedial Investigation results, and it seems safe to assume that the oil contains greater than 500 ppm PCB. However, in three of the four analyses of the lagoon sediment, the PCB levels were low, whereas in the fourth sediment sample the PCB concentration was exceptionally high. This wide variation in the PCB content of similar samples (the sediment collected for the Treatability Study was homogenized before repackaging and shipping to the potential disposers) could be the result of different analytical techniques being used by different labs, or the sediment being extremely nonhomogeneous in its PCB distribution, even when thoroughly mixed. Nevertheless, the original assumption that the sediment contains greater than 500 ppm PCB (based on the Remedial Investigation results) may need re-evaluation. If it can be assumed that the sediment contains less than 500 ppm PCB (or possibly less than 50 ppm PCB), then the available disposal options for the sediment would become somewhat more diverse. Also, if it can be assumed that the sediment contains less than 500 ppm PCB (while it is still assumed that the oil contains greater than 500 ppm PCB), then the question as to whether the oil should be removed before the water level of the lagoon is lowered or after the lagoon level is lowered becomes a critical concern.

TABLE A-2

SUMMARY OF ANALYSES FROM TREATABILITY STUDY
LAGOON OIL PHASE
BRIDGEPORT RENTAL AND OIL SERVICES SITE

	Laboratory			
Parameter	NUS	RECRA Research	ENTEK Labs	At-Sea-Incineration
Total PCB (µg/g)	820	690	882	105
Organic Halides (µg/g)	2.5	-[3]	-	-
Chlorine (µg/g)	-	<1000	1393	3300
Ash (%)	1.1	-	1.48	2.7
Heat Value (BTU/lb)	WNC	10,450	8,482	9,818
Flash Point[1] (°F)	<140	<180	-	<210
Moisture (%)	28.6	-	-	48
pH	4.7	-	5.0	4.35
Phosphorus (mg/kg)	13	-	-	-
Specific Gravity (g/ml)	0.945	0.95	0.80	0.954
Sulfur (%)	<0.05	-	-	0.28
Viscosity	13,700[2]	Med-High	-	40,679[4]
Arsenic (mg/kg)	0.1	-	-	0.4
Barium (mg/kg)	40	-	-	181
Cadmium (mg/kg)	<0.1	-	-	1.0
Chromium (mg/kg)	2.0	-	-	29
Copper (mg/kg)	10	-	-	19
Lead (mg/kg)	160	-	-	1525
Mercury (mg/kg)	<0.15	-	-	0.25
Nickel (mg/kg)	1.0	-	-	6.0
Selenium (mg/kg)	<0.1	-	-	0.05
Silicon (mg/kg)	16,000	-	-	-
Silver (mg/kg)	<0.3	-	-	0.2
Thallium (mg/kg)	<2.5	-	-	2.0
Zinc (mg/kg)	15	-	-	66
Titanium (mg/kg)	<13	-	-	-
Sodium (mg/kg)	30	-	-	-

[1]Penske-Marten Closed Cup
[2]Centipoise
[3]Dash (-) indicates analysis not performed
[4]Saybolt Universal seconds @ 70°F
WNC = Will Not Combust

Source: Compilation by NUS Corporation, Pittsburgh, Pennsylvania, April 1984

TABLE A-3

SUMMARY OF ANALYSES FROM TREATABILITY STUDY
LAGOON SEDIMENT PHASE
BRIDGEPORT RENTAL AND OIL SERVICES SITE

	Laboratory			
Parameter	NUS	RECRA Research	ENTEK Labs	At-Sea-Incineration
Total PCB (μg/g)	14	18.5	2010	7.5
Organic Halides (μg/g)	1.4	-	-	-
Chlorine (μg/g)	-	<1000	-	-
Ash (%)	66.9	-	65.4	75.1
Heat Value (BTU/lb)	WNC	1270	-	-
Flash Point[1] (°F)	<140	<180	-	-
Moisture (%)	27.6	-	-	-
pH	6.7	-	6.0	-
Phosphorus (mg/kg)	0.58	-	-	-
Specific Gravity (g/ml)	1.77	1.2	1.46	1.65
Sulfur (%)	<0.05	-	-	-
Viscosity	54,000[2]	High	-	127,060[4]
Arsenic (mg/kg)	7.6	0.53	-	-
Barium (mg/kg)	95	-	-	-
Cadmium (mg/kg)	0.65	0.45	-	-
Chromium (mg/kg)	12	25	-	-
Copper (mg/kg)	8.2	12	-	-
Lead (mg/kg)	760	368	-	-
Mercury (mg/kg)	0.1	0.03	-	-
Nickel (mg/kg)	9.2	31	-	-
Selenium (mg/kg)	0.25	<0.05	-	-
Silicon (mg/kg)	320,000	-	-	-
Silver (mg/kg)	<0.3	0.35	-	-
Thallium (mg/kg)	4.0	0.82	-	-
Zinc (mg/kg)	32	95	-	-
Titanium (mg/kg)	<13	-	-	-
Sodium (mg/kg)	290	-	-	-
Antimony (mg/kg)	-	0.59	-	-
Beryllium (mg/kg)	-	0.44	-	-

[1]Penske-Marten Closed Cup
[2]Centipoise
[3]Dash (-) indicates analysis not performed
[4]Saybolt Universal seconds @ 70°F
WNC = Will Not Combust

Source: Compilation by NUS Corporation, Pittsburgh, Pennsylvania, April 1984

In other words, if the lagoon level is dropped while the oil is still in place, then the oil may coat the lagoon sediment, and thus qualify the lagoon sediment as containing greater than 500 ppm PCB. On the other hand, if the oil is removed before the lagoon level is lowered, then the lagoon sediment could possibly be treated as containing less than 500 ppm PCB, in which case it could conceivably be stabilized in place or disposed of in an approved chemical waste landfill (resulting in substantial savings in disposal costs).

A.5 Incinerator Responses

Of the previously identified incinerators the following responses were received concerning disposal of the lagoon oil and/or sediment.

- ASI

  The lagoon sediment is definitely unsuitable for ASI's ocean-going incineration vessel. (The sediment is far too high in solids.)

  The lagoon oil is acceptable; however, the oil would need to be blended with other, "thinner" solvents to reduce its viscosity. One potential problem is the high lead content of the oil observed by ASI (1525 ppm Pb). ASI's limit on lead is 100 ppm. ASI is permitted to blend wastes to strive for an overall lead content of 100 ppm; however, if 1525 ppm Pb is truly representative, then ASI feels that far too much dilution and blending would be required. (The NUS laboratory detected only 160 ppm Pb in the lagoon oil, a Pb level which is acceptable to ASI).

  ASI cost estimate for incineration of lagoon oil (not including transportation):

  Cost: $0.32/lb. of oil

- CWM - No response on incineration of lagoon oil or sediment.

- ENSCO

ENSCO gave preliminary acceptance of the lagoon oil and the lagoon sediment for incineration using either the permanent facility in El Dorado, Arkansas, or using the Pyrotech mobile incinerator. If the mobile incinerator is used, then a permit from the State of New Jersey would be required. Acquiring this permit may be difficult and would depend upon the sentiments of the State of New Jersey. The necessary State permit is reportedly similar to a TSCA Part A and Part B permit, and the time necessary to secure this permit, assuming a favorable State attitude, is expected to be about one year.

ENSCO cost estimate for incineration at the El Dorado, Arkansas, facility (not including transportation of the waste or disposal of the residual ash):

Cost: $0.20/ lb of oil
$0.50/lb of sediment

ENSCO cost estimate for onsite incineration using the Pyrotech mobile incinerator (not including any site work, such as excavation of the sediment or collection of the oil, or disposal of any residual ash):

Cost: $0.10/lb of oil
$0.10/lb of sediment

- Rollins - No response on incineration of lagoon oil or sediment.

- SCA

SCA gave preliminary acceptance of the lagoon oil and lagoon sediment for incineration at the Chicago facility.

SCA cost estimate for incineration of the lagoon oil and sediment (the cost does not include transportation of the waste, but does include disposal of all residual ash at SCA's hazardous waste landfill in Fort Wayne, Indiana):

Cost: $0.27/lb of oil
$0.61/lb of sediment

One point that came across very clearly in all correspondences with prospective waste disposers was that since January 1, 1984, all licensed PCB incinerators have been swamped with incineration requests because of changes in the regulations for storage of PCB articles. Therefore, if offsite incineration is to be used as the method of disposal for the lagoon oil and/or sediment, then requests to the selected incineration facility(s) should be made as far in advance as possible to ensure that the incinerator has the available capacity at the time shipment is anticipated, especially for the quantities of PCB waste that are present at the BROS Site. Likewise, if onsite incineration is to be used, then plans should be made well in advance since the permitting process may take a year or more.

A.6 Further Development of Disposal Costs

As is evident in the previous discussion of responses from prospective disposers, the cost estimates provided are difficult to compare because some facilities are much nearer to the site than others and because some estimates include additional services (such as residual ash disposal) while other estimates do not. In order to provide a consistent basis for the various disposal alternatives to be evaluated, a more detailed cost estimate for lagoon waste disposal will be developed in this section. The bases and assumptions that are used to develop these cost estimates are presented below:

- All cost estimates are developed on a "per pound of starting material" basis.

- Cost estimates will not include any site work, such as sediment excavation, oil collection, etc. Site work is included elsewhere in this report as a separate cost item.

- Cost estimates for disposal are based on the waste's having been already removed from the lagoon and placed in a temporary storage tank or bin. The cost estimates presented here include the cost to pump or convey the waste from the temporary storage container to the onsite incinerator or to haul the waste to its offsite point of disposal. The cost of the temporary storage containers is not included in this estimate. Also included is the cost for transportation and disposal of any residual ash (from incineration) at an approved chemical waste landfill. In the case of direct landfilling of the lagoon sediment, the cost for appropriate stabilization of the sediment is included. For stabilizing and landfilling the sediment, it is assumed that the sediment will be determined to fall into the 50 to 500 ppm PCB category, and that the stabilized sediment will have a load-bearing capacity of 150 pounds per square foot.

- The heat of combustion of the lagoon oil is 10,000 BTU/lb; the heat of combustion of the sediment is 1,000 BTU/lb.

- The ash content of the oil is two percent; the ash content of the sediment is 70 percent.

- The sediment is a pumpable material and therefore can be hauled in bulk to an offsite incinerator. (If the sediment is not pumpable, then it would require packaging in incinerable drums before being hauled to an offsite incinerator).

- Hauling cost estimates are based on 40,000 pound loads at $5.00 per loaded mile.

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A.6.1 ASI – Incineration Aboard Ocean-Going Vessel

Oil Phase

- Hauling

Bridgeport to Philadelphia ≃ 20 miles

$$\frac{20 \text{ miles/load} \times \$5.00\text{/mile}}{40{,}000 \text{ lbs/load}} = \$0.0025\text{/lb. oil}$$

① Seems unrealistic for a trucker to make the trip for $100.. The per mile cost would be much higher

- Incineration (assuming Pb levels are acceptable)

Incineration cost (supplied by ASI) = **$0.320/lb. oil**

Disposal Cost for Oil at ASI

Hauling + incineration + 20% contingency = $0.386/lb. oil

Sediment Phase

Unacceptable for disposal at ASI

② Won't the hauler charge additional money to carry the hazardous waste for any distance — since it involves greater risk and therefore higher insurance cost to cover the perils if there is a spill or mishap.

A.6.2 ENSCO – Incineration at El Dorado, Arkansas

Oil Phase

- Hauling

Bridgeport to El Dorado = 1,300 miles

$$\frac{1{,}300 \text{ miles/load} \times \$5.00\text{/mile}}{40{,}000 \text{ lb./load}} = \$0.162\text{/lb. oil}$$

③ Is it permissible to haul hazardous waste through various states? What kind of permits, clearances and insurance will be required and their impact on the overall hauling costs.

- Incineration

  Incineration cost (supplied by ENSCO) = **$0.200/lb. oil**

- Ash disposal at CWM chemical waste landfill in Emelle, Alabama

  - hauling

    El Dorado, Arkansas to Emelle, Alabama = 300 miles

$$\frac{300 \text{ miles/load} \times \$5.00\text{/mile}}{40{,}000 \text{ lb./load}} = \$0.0375\text{/lb. ash}$$

  - Disposal

    Disposal cost (supplied by CWM, including applicable State and Federal taxes) = $73/ton = $0.036/lb.

  - Total - ash disposal

    Hauling and disposal fee = $0.0735/lb. ash

    $0.0735/ lb. ash x 0.02 lb. ash/lb. oil = **$0.0015/lb. oil**

Disposal Cost for Oil at El Dorado

Hauling + incineration + ash disposal + 20% contingency = $0.437/lb oil

<u>Sediment Phase</u>

- Hauling (see oil phase cost development for detail)

  Hauling cost (assuming pumpable) = **$0.162/lb. sediment**

- Incineration

  Incineration cost (supplied by ENSCO) = **\$0.500/lb. sediment**

- Ash Disposal (see oil phase cost development for detail)

  Ash Disposal cost = \$0.0735/lb ash x 0.7 lb. ash/lb sediment = **0.052/lb. sediment**

Disposal Cost for Sediment at El Dorado

Hauling + incineration + ash disposal + 20% contingency = \$0.857/lb. sediment

A.6.3 ENSCO/Pyrotech – Onsite Incineration

<u>Oil Phase</u>

- Incineration

  Incineration cost (provided by Pyrotech) = **0.100/lb. oil**

- Ash Disposal (at CECOS Niagara Falls)

  - Hauling (see A.6.5 for detail) = \$0.05/lb. ash

  - Disposal Fee (see A.6.5 for detail) = \$0.0475/lb. ash

  - Total Ash Disposal Cost

    Hauling and Disposal Fee = \$0.0975/lb. ash

    \$0.0975/lb ash x 0.02 lb. ash/lb oil = **\$0.002/lb. oil**

Disposal Cost for Oil - Onsite Incineration

Incineration + Ash Disposal + 20% contingency = $0.122/lb oil

<u>Sediment Phase</u>

- Incineration

  Incineration cost (provided by Pyrotech) = **$0.100/lb. sediment**

- Ash Disposal (at CECOS Niagara Falls)

  - Hauling cost = $0.05/lb. ash
  - Disposal Fee = $0.0475/lb. ash
  - Total Ash Disposal Cost

    Hauling and Disposal Fee = $0.0975/lb. ash

    $0.0975/lb. ash x 0.7 lb. ash/lb. sediment =

    $0.0682/lb. sediment

Disposal Cost for Sediment-Onsite Incineration

Incineration + Ash Disposal + 20% contingency = $0.202/lb. sediment

A.6.4 SCA - Incineration at Chicago, Illinois

Oil Phase

- Hauling

Bridgeport to Chicago = 800 miles

$$\frac{800\ \text{miles/load} \times \$5.00/\text{mile}}{40{,}000\ \text{lb/load}} = \quad \textbf{\$0.100/lb. oil}$$

- Incineration (including ash disposal)

Incineration Cost (supplied by SCA) = **$0.270/lb. oil**

Disposal Cost for Oil at SCA

Hauling + incineration + 20% contingency = $0.444/lb. oil

Sediment Phase

- Hauling (see oil phase cost development for detail)

Hauling Cost = **$0.100/lb. sediment**

- Incineration (including ash disposal)

Incineration cost (supplied by SCA) = **$0.610/lb. sediment**

Disposal Cost for Sediment at SCA

Hauling + Incineration + 20% contingency = $0.852/lb. sediment

A.6.5 CECOS International – Stabilization and Chemical Waste Landfilling at Niagara Falls, New York

Oil Phase

Stabilization and chemical waste landfilling of the oil phase was not considered to be appropriate since the oil phase is a liquid that appears to contain greater than 500 ppm PCB.

Sediment Phase

- Stabilization (including labor, equipment, and materials)

  Stabilization Cost (provided by Velsicol, Inc.) = **$0.025/lb. sediment**

- Hauling

  Bridgeport to Niagara Falls ≈ 400 miles

  $$\frac{\text{400 miles/load x \$5.00/mile}}{\text{40,000 lb./load}} = \text{\$0.05/lb. stabilized material}$$

  Assuming 20 percent weight increase from stabilization process

  Hauling cost = $0.05/lb stabilized x 1.2 lb. stabilized/lb. sediment = **$0.060/lb. sediment**

- Disposal fee at CECOS – Niagara Falls

  Disposal fee (including State and Federal taxes) = $95/ton

  $95/ton stabilized = $0.0475/lb. stabilized x 1.2 = **$0.057/lb. sediment**

Disposal Cost for Stabilized Sediment at CECOS – Niagara Falls

Stabilization + Hauling + Disposal Fee + 20% contingency = $0.170/lb. sediment

A.6.6 CECOS International – Stabilization and Chemical Waste Landfilling at Cincinnati, Ohio

Oil Phase

Stabilization and chemical waste landfilling of the oil phase was not considered to be appropriate since the oil phase is a liquid that appears to contain greater than 500 ppm PCB.

Sediment Phase

- Stabilization (including labor, equipment, and materials)

  Stabilization cost (provided by Velsicol, Inc.) = **$0.025/lb. sediment**

- Hauling

  Bridgeport to Cincinnati ≈ 600 miles

  $$\frac{600 \text{ miles/load} \times \$5.00\text{/mile}}{40{,}000 \text{ lb/load}} = \$0.075\text{/lb. stabilized}$$

  Assuming 20 percent weight increase from stabilization process

  Hauling cost = $0.075/lb. stabilized x 1.2 = **0.090/lb. sediment**

- Disposal Fee at CECOS - Cincinnati

  Disposal fee (including State and Federal taxes) = $90/ton

  $90/ton stabilized = $0.045/lb. stabilized x 1.2 = **$0.054/lb. sediment**

Disposal Cost for Stabilized Sediment at CECOS - Cincinnati

Stabilization + Hauling + Disposal Fee + 20% contingency = $0.203/lb. sediment

A.6.7 CWM - Stabilization and Chemical Waste Landfilling at Emelle, Alabama

Oil Phase

Stabilization and chemical waste landfilling of the oil phase was not considered to be appropriate since the oil phase is a liquid that appears to contain greater than 500 ppm PCB.

Sediment Phase

- Stabilization (including labor, equipment, and materials)

  Stabilization cost (provided by Velsicol, Inc.) = **$0.025/lb. sediment**

- Hauling

  Bridgeport to Emelle, Alabama ≃ 1,000 miles

  $$\frac{\text{1,000 miles/load x \$5.00/mile}}{\text{40,000 lb/load}} = \text{\$0.125/lb. stabilized}$$

  Assuming 20 percent weight increase from stabilization process

$0.125 lb/stabilized x 1.2 = **$0.150/lb. sediment**

- Disposal Fee

Disposal cost (including State and Federal Taxes) = $73/ton

$73/ton stabilized - $0.0365/lb. stabilized x 1.2 = **$0.0438/lb. sediment**

Disposal Cost for Stabilized Sediment at CWM – Emelle, Alabama

Stabilization + Hauling + Disposal Fee + 20% contingency = $0.263/lb. sediment

A.7 Treatability Study Summary

From this treatability study and from a review of applicable regulations, it is evident that only two disposal options are available for the oil: onsite incineration and offsite incineration. Three disposal options appear available for the lagoon sediment: onsite incineration, offsite incineration, and stabilization with offsite landfilling (stabilization and landfilling carry the caveat that the sediment contains less than 500 ppm PCB). The alternative of stabilizing the sediment and redisposing of it in the lagoon could not be evaluated because the analytical data on the leachability characteristics of the stabilized sediment have not yet been received by NUS as of this writing (April 1984). Nevertheless, regardless of the results for the leachability of the stabilized sediment, it is unlikely that State or Federal environmental regulatory agencies will approve of the onsite redisposal option.

Following the identification of the applicable disposal options, cost estimates were solicited from the identified potential disposal firms. Using the estimates provided by some of the potential disposers, detailed disposal cost estimates were developed. A summary of these estimates is presented in Table A-4. From this cost development it is evident that the least expensive disposal option for the oil

TABLE A-4

DISPOSAL COST ESTIMATES FOR BROS
LAGOON OIL AND SEDIMENT
BRIDGEPORT RENTAL AND OIL SERVICES SITE

Disposal Firm	Disposal Method	Disposal Cost Estimate(1)	
		Oil Phase	Sediment Phase
At-Sea-Incineration, Inc.	Incineration at sea	$0.386/lb.	Unacceptable
ENSCO	Incineration at El Dorado, Arkansas	$0.437/lb.	$0.857/lb.
SCA Services	Incineration at Chicago, Illinois	$0.444/lb.	$0.852/lb.
ENSCO/Pyrotech	Onsite incineration	$0.122/lb.	$0.202/lb.
CECOS International	Landfilling at Niagara Falls, New York	Unacceptable	$0.170/lb.(2)
CECOS International	Landfilling at Cincinnati, Ohio	Unacceptable	$0.203/lb.(2)
Chemical Waste Management, Inc.	Landfilling at Emelle, Alabama	Unacceptable	$0.263/lb(2)

(1) Disposal cost estimates include labor, equipment, materials, hauling, fees, and taxes associated with disposal; however, the costs for removal of the oil or sediment from the lagoon are not included.

(2) Assumes sediment contains between 50 and 500 ppm PCB; costs include onsite stabilization of the sediment.

Source: Compilation by NUS Corporation, Pittsburgh, Pennsylvania, April 1984.

phase is onsite incineration. The costs for offsite oil incineration were roughly three times more expensive. Similarly, onsite incineration of the lagoon sediment is also the least expensive of the incineration options and is less expensive than two of the the three stabilization and landfilling options. Only the option of stabilizing the lagoon sediment and landfilling it at CECOS in Niagara Falls, New York, was less expensive than onsite incineration, and not by a significant amount. Furthermore, the "stabilization with landfilling" alternatives assume that the lagoon sediment falls into the 50 to 500 ppm PCB range; this assumption does not need to be made for the onsite incineration alternative.

The evaluation of lagoon remediation alternatives presented in Section 5 of this report uses the lowest cost disposal option for each of the identified disposal categories; that is, the onsite incineration cost for the oil and for the sediment is from the Pyrotech cost estimate (the only estimate available). The offsite oil incineration cost used in the evaluation is the ENSCO estimate, and the offsite sediment incineration cost is the SCA estimate. The cost used in the evaluation for the "sediment stabilization and offsite landfilling" option is from the CECOS-Niagara Falls estimate.

APPENDIX B

B.1 Groundwater Modeling

B.1.1 Purpose

The purpose of simulating groundwater flow beneath the Bridgeport Rental and Oil Services Site is as follows:

- To estimate the permeability of the oily sludge on the sides and bottom of the lagoon

- To estimate the effects on contaminant plume migration of the following remedial action alternatives:

  - Lagoon Mounding - leave the existing lagoon, dikes, and groundwater mound in place.

  - Plume Dispersion - reduce the fluid level in the lagoon to the surrounding water table level, grade off dikes, and observe plume migration through dispersion.

  - Scavenging Wells - pump four existing monitoring wells at 100 gpm each and observe the effects on plume migration and concentration.

- To estimate the pumping rate that would be required to completely scavenge the contamination plumes.

B.1.2 Models

Two models were run on the unconfined Magothy aquifer at the BROS Site. The Prickett-Lonquist Aquifer Simulation Model (PLASM) was used to simulate the permeability of the oily sludge in the BROS lagoon. The Random Walk version of the Solute Transport and Dispersion Model (SOLUTE) by Prickett was used to simulate the effects of the remedial action alternatives described previously. The models were run on a COMPAQ portable microcomputer with MS-DOS in Microsoft BASIC.

PLASM is a two-dimensional, finite-difference model which solves matrices of input data consisting of head, transmissivity, and storage values. The model uses the Alternating Direction Implicit (ADI) method to solve a series of finite difference equations by Gaussian elimination. The finite difference equations are derivatives of the partial differential equation governing nonsteady, two dimensional flow of groundwater in an artesian, nonhomogeneous, isotropic aquifer.

SOLUTE is a two-dimensional finite-difference model which solves matrices of input data consisting of transmissivity, storage, dispersion, velocity and contaminant concentration values. The effects of advection, dispersion, and chemical reactions are included. The groundwater flow equation is solved in a manner similar to that used in PLASM. Dispersion of contaminants is simulated by applying scalar probability curves related to flow length and dispersion coefficients to input values of contaminant concentrations (Prickett, Naymik, and Lonquist, 1981).

B.1.3 Input Data

The groundwater models were based on the following assumptions.

- Flow Model

  The aquifer was modeled as two-dimensional, non-steady state, heterogeneous, and anisotropic with unconfined conditions. The transmissivity of the oily sludge in the lagoon was varied over several simulations in order to recreate the mounding effects of the lagoon.

Recharge boundaries (such as ponds) and groundwater mounding from topographic high points were also simulated.

- Transport Model

  The transport model was a two-dimensional, homogeneous, and isotropic simulation under unconfined conditions. In order to simulate a worst-case situations no retardation of contaminant migration was assumed to have occurred from interaction between the contaminant and the groundwater or aquifer. The concentration of chlorides in the monitoring wells were used to simulate contaminant dispersion at the beginning of the model.

  The actual contaminants are mostly organic chemicals; therefore, some interaction may occur between the contaminants and the groundwater or aquifer.

The size and spacing of the two-dimensional grid was smaller for the groundwater flow model since the lagoon mounding was the center of the investigation. The grid size was enlarged for the contaminant transport simulations to demonstrate the extent of plume dispersion.

B.1.3.1 Flow Model (PLASM)

Input data for the PLASM flow model consisted primarily of head, transmissivity, storage, and pumping values. The head data was taken from the elevations of the lagoon and surrounding ponds and swamps shown on the site topographic map. Since the aerial photography on which the topographic map was based was conducted prior to installation of NUS monitoring wells at the site, an exact match of head data between the lagoon and groundwater contours developed from the monitoring wells was not possible. The hydraulic gradient surrounding the site is relatively flat, and the default head was set to elevation 3.2 feet. The lagoon elevation was set to 14.1 feet.

Transmissivity and storage values were calculated from a pumping test of monitoring well S-3C conducted by NUS geologists in September 1983. The default transmissivity was input as 38,000 gpd/ft. The default storage was 0.014. Storage values were increased to 10,000 at the Gaventa and Swindell ponds and to 1,000 along the berm of Rt. 130 to reflect recharge and constant head boundary conditions (Prickett, 1971). Discharge (pumping) values were set to zero throughout the entire simulation period of 1 year.

A 2-dimensional grid consisting of 11 columns and 11 rows spced at 125 foot intervals was superimposed over the lagoon and surrounding aquifer. Values for head, storage, transmissivity, and discharge were provided for each node in the grid. The finite difference equations were then developed from the values at each grid node.

B.1.3.2 Transport Models (SOLUTE)

Basic transport coefficients such as transmissivity, storage, hydraulic conductivity, and groundwater velocity were calculated from the pumping test mentioned previously.

Transmissivity	= 38,000 gpd/ft
Storage (specific yield)	= 0.014
Hydraulic Conductivity	= 321 gpd/ft^2 ✓
Groundwater Velocity	= 0.03 ft/day

you have 0.056 ft/day on p. 3-30 in the R.I. draft?

The velocity changes with the hydraulic gradient. Thus, the groundwater velocity was a function of the hydraulic gradient between the lagoon surface and the surrounding water table in the Lagoon Mounding simulation and was increased to 0.13 ft/day.

The porosity of the sand aquifer was calculated as 0.38 from grain size analyses of samples collected during drilling of the monitoring wells. The longitudinal and transverse dispersion coefficients were estimated from empirical values for sand aquifers with a porosity of 0.40 (Anderson, 1979). The retardation coefficient was set to 1 to reflect no chemical reaction between the contaminant and the groundwater or aquifer. This would simulate a worst-case situation.

Contaminant particles were placed at nodes in a 2-dimensional grid overlying the site. The distribution of contaminant particles reflects the concentration of chlorides in groundwater samples obtained from monitoring wells on the site. After several computer runs, the best "fit" was obtained by simulating a circle with a radius of 750 feet in which 30 particles were distributed. A multiplication factor of 10 is necessary to convert particle concentration to actual contaminant concentration; i.e., 3 particles equal 30 mg/l. Particle distribution is shown on the simulation output.

In the Scavenging Well simulation, monitoring well clusters S-1, S-2, S-3 and S-11 were modeled as four sinks each discharging 100 gpm. Total pumping was limited to 400 gpm due to existing water treatment plant capacity.

A 2-dimensional grid consisting of 7 rows and 9 columns spaced at 500 foot intervals was superimposed over the site. The grid covers the lagoon, the Swindell and Gaventa ponds, Little Timber Creek and Cedar Creek swamps, and Little Timber Creek itself. Basic transport coefficient values were input at each node in the grid. The finite-difference equations were developed from values at each grid node.

The solute transport models were simulated over a 30-year period in 10-year increments.

B.1.4 Simulation Results

B.1.4.1 Flow Model (PLASM)

The transmissivity of the oily sludge in the bottom of the lagoon was varied over several computer runs. The computer model determined that the sludge needed a transmissivity of nearly zero and a storage (specific yield) of 0.00001 to maintain the existing hydrostatic head in the lagoon. An exact reproduction of the groundwater mound was not possible since the aerial photograph, from which the topographic map was developed, was taken before water levels were measured in the monitoring wells.

The flow model indicates that the berm along Rt. 130 provides a recharge barrier north of the site which may retard contaminant plume migration in that direction.

B.1.5 Solute Transport Models (SOLUTE)

B.1.5.1 Lagoon Mounding

The results of the Lagoon Mounding simulation indicated that the contaminant plume migrated about 750 feet northeast into Little Timber Creek swamp and 500 feet west into the Gaventa orchard over a 10-year period. By 20 years, the plume had moved 1,500 feet northeast, as shown by a particle concentration of 1 (1 particle equals 10 mg/l). The plume dispersed below the 10 mg/l limit west of the lagoon after 20 years. By 30 years, the plume had advanced about 2,000 feet northeast into Little Timber Creek.

Does this paragraph refer to plume dispersion from present to future ??? Confusing

B.1.5.2 Plume Dispersion

This simulation involved removing the impounded liquids and surrounding dike, and simulating plume migration by dispersion with little or no advective transport because of the low hydraulic gradient. The 10 mg/l contaminant plume limit had dispersed 500 feet north, northeast and east after a 30-year simulation period. No dispersion above the 10 mg/l limit was observed south and west of the lagoon after 30 years.

B.1.5.3 Scavenging Wells

The existing monitoring well clusters at four locations surrounding the lagoon were simulated as discharging 400 gpm over a 30-year period. Pumping the wells retarded plume dispersion 100 to 250 feet; however, due to the highly transmissive nature of the aquifer, the plumes were not "scavenged" by the pumping wells. The wells were pumping at a low rate in a very permeable aquifer and did not overcome the effects of dispersion.

During the Scavenging Well field model, several computer simulations were executed to estimate the pumping rate which would be required to completely scavenge the existing contamination plume. The pumping rate and number of scavenging wells were gradually increased and the particle concentrations observed after each computer simulation. The model indicated that a total pumping rate of 19,000 gpm at nine locations would be required to scavenge the existing plume in a 5-year period.

B.1.6 Conclusions

The flow model (PLASM) indicates that the permeability of the oily sludge in the BROS lagoon is very low, and this fact accounts for the presence of impounded liquids and occasional overflow into surrounding ponds and swamps. The highway berm along Rt. 130 north of the side provides a recharge barrier which may impede plume migration to the north.

The solute transport models (SOLUTE) indicate that reducing the liquid level in the lagoon and grading off the surrounding dikes will remove the mechanism of advective contaminant transport, and reduce the extent of plume migration from about 2,000 feet to 500 feet over a 30-year period. Scavenging wells pumping 400 gpm for 30 years may reduce contaminant migration 100 to 250 feet; however, no significant plume removal by groundwater scavenging will occur. Groundwater extraction rates of about 19,000 gpm were calculated to be necessary to completely remove the contamination plumes within a 5-year period.

LITTLE TIMBER CREEK
COOPER LAKE
LITTLE TIMBER CREEK SWAMP
ROUTE 130
CROWN POINT ROAD
CEDAR SWAMP ROAD
BROS LAGOON
CEDAR CREEK SWAMP
GAVENTA POND
SWINDELL POND
CHEMICAL LEAMAN
FISH DIESEL REPAIR
BELL
HILLMAN
FRYBERGER
CAHILL
NEWTON
LINDLE
BYRNES
AUGUST
WILSON
MIKULETSKY
TREW
KELLER (VAN SCOY)
SNYDER
LA SERRA
PARISI
BECKETT
S-12
EPA-107
S-6
EPA-106
EPA-105
EPA-104
EPA-103
EPA-102
EPA-101
EPA-108
S-2C
S-2B
S-2A
S-3A, B, C
S-9
S-5
S-6
CL-1
CL-2
CL-3
CL-4
CL-5
DW-2
TP-4
TP-16
3.25
3.50
3.75
4.00
4.25
4.50
E 1,812,000
E 1,813,000
E 1,814,000
E 1,815,000
E 1,816,000
E 1,817,000
E 1,818,000
N 354,000
N 353,000
N 352,000
N 351,000
ELEVATIONS AND CONTOURS ARE IN FEET ABOVE MEAN SEA LEVEL
No. NGVD!
LEGEND
GROUNDWATER ELEVATION CONTOUR (AS OF 12/23/83)
MONITORING WELL (CHEMICAL LEAMAN WELL LOCATIONS ESTIMATED FROM CDM WORK PLAN, VOLUME II, APPENDICES, DECEMBER 1981)
SECTION LINE
TEST PIT
DOMESTIC WELL
ESTIMATED LOCATION OF MAJOR CONTAMINANT PLUMES BENEATH BROS SITE
GRAPHIC SCALE
ALL LETTERING MIN. 1/8"
DRAWN
CHECKED
DESIGN ENGINEER
PROCESS ENGINEER
PROJECT MANAGER
DIVISION MANAGER
CLIENT APPROVAL
APPROVED
DATE
REFERENCE
DWG. NO.
DATE
NO.
REVISION
BY
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NUS CORPORATION
A Halliburton Company
PARK WEST TWO
CLIFF MINE ROAD
PITTSBURGH, PA 15275
MONITORING WELL LOCATIONS
CLIENT
BRIDGEPORT RENTAL & OIL SERVICES
CONTRACT
070715
SCALE 1" = 200' 1' C.I.
DATE
SEPT. 20, 1983
SHEET 1 OF 1
DRAWING NO.
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Prepared by KUCERA


GRID SHOWN IN FIGURE 3-5
BROS LAGOON
POSITION
LINE
MAGNETIC
CONTOURS INDICATE TOTAL MAGNETIC FIELD INTENSITY
MEASURED IN GAMMAS. BASE LEVEL=50,000 GAMMAS.
LEGEND
PROFILE LINE
ANOMALOUS AREA
GRAPHIC SCALE
ALL LETTERING MIN. 1/8
REFERENCE
DWG. NO.
DATE
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PARK WEST TWO
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PITTSBURGH, PA 15275
TOTAL MAGNETIC FIELD INTENSITY CONTOUR MAP
BROS LAGOON AREA
CLIENT
BRIDGEPORT RENTAL & OIL SERVICES
CONTRACT
0707.15
SCALE 1" = 50'
DATE FEB. 28, 1984
SHEET 4 OF 4
DRAWING NO. 0707.15 - 04
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